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Transforming Enabling Processes: The Next Step in Logistics Reform

Colonel Arthur B. Morrill III., USAF

> When it comes down to the wire and the enemy is upon you and you reach into your holster, pull out the pistol and level it at your adversary, the difference between a click and a bang is logistics.[1]
>
> —Editors of *Loglines*

Introduction

In the early to mid-1990s, the Air Force introduced Lean Logistics and its key elements—two levels of maintenance, shorter repair cycles and rapid delivery.[2] While Lean Logistics initiatives significantly altered Air Force logistics, much remains to be changed. Today, the Air Force needs like innovation in all processes *affecting* (enabling) logistics to realize a dramatically better performing warfighter support system.

Lean Logistics: The Air Force Weight Loss Program

The application of Lean Logistics concepts and initiatives made Air Force logistics resources and processes leaner. It was a necessary transformation. The Air Force was carrying the fiscal burden of inventories that were too large, which drove opportunity costs. Maintenance cycles were too long. Distribution pipeline segments were lethargic and plagued with bottlenecks.

In response, the Air Force reduced its inventory, its logistics population and its intermediate-level maintenance locations. Lean Logistics initiatives did result in cost savings, cost avoidance and the reduction of inventory and infrastructure. However, the Air Force increased its use of contractor field teams, its in-garrison and deployed optempo and its per capita reliance on a shrinking workforce. Significantly, the Air Force neither notably nor concurrently reformed processes enabling logistics success. The result: logistics initiatives did not significantly improve customer satisfaction.

Reengineering selected Air Force logistics processes under the aegis of Lean Logistics or, recently, Agile Logistics is not enough if we do not simultaneously reform enabling processes. As a complementing activity, we must also develop customer-oriented metrics to assess our performance, quantify our progress and predict future supportability states. Ideally, these should largely be leading indicators derived from independent variables. Dramatic improvements to enabling processes and performance indicators are central to this needed breakthrough in logistics, the object being to significantly improve the warfighter support system's performance.

There are three major activities in the warfighter support system. Foremost is the customer, otherwise known as supported activities. From an Air Force perspective, they include Air Force major commands (MAJCOMs) and joint theater commanders-in-chief. Second are supporting activities, such as Air Force Materiel Command, selected MAJCOM activities (for example, engine regional repair centers) and the Defense Logistics Agency (DLA). Third in this warfighter support system are logistics enabling activities, such as headquarters staffs, staff support activities and, importantly, major functional areas—information technology, comptroller and policy.

"Unfortunately, today, our Acrobat® and PowerPoint® presentations have better technology than our logistics [enabling processes]."[3] Fortunately, in an era of process reengineering and reform, enabling activities offer the greatest possibility for dramatic improvement to Air Force logistics performance and, therefore, customer support. Lon Roberts, writing on improving organizational performance, cited ten tenets of process reengineering in his book *Process Reengineering: The Key to Achieving Breakthrough Success.* Tenet 3 is operative: "Business processes—the domain of the so-called white collar worker—hold the potential for quantum leaps in improvement."[4] Roberts continued:

> As important as product improvement and productivity enhancements are to a company's competitive position, an additional area of concern deserves equal, sometimes more, consideration: the effectiveness and efficiency of the business processes that support the development and delivery of the organization's products and services.[5]

Transformed Enabling Processes: Air Force Muscle Toning

To dramatically improve operations support, enabling processes must be transformed. Like many areas of the private sector, they must become real-time data delivery systems; incremental improvement is insufficient to the task. Radically transformed processes must be the result, supported thereafter by prudent, holistic continuous improvement. Foremost among the enabling activities requiring this dramatic transformation is the information technology (IT) arena. The reason is clear:

> The requirement for timely management information will increase dramatically . . . as time becomes a critical factor in competitiveness. Unfortunately, most companies are not prepared for the challenge. To be a world-class manufacturer in the twenty-first century will require superior communication and information management capabilities designed to carry

information both vertically and horizontally throughout the organization. Goals will include real-time data transfer and information enhancement through artificial intelligence-based communications.[6]

This approach presumes the pursuit and timing of technology specifically support strategic goals and objectives. Therefore, it directly facilitates achieving of quantifiable logistics outputs—the effectiveness of which can only be determined by the customer (warfighter).

Unfortunately, the pursuit of information technology improvements is often disconnected from user and customer satisfaction. Technology becomes an end in itself instead of a means to an end. Franklin S. Reeder, head of a Washington-based consulting firm, points out IT "managers must overcome their fascination with technology and show how . . . [they specifically] contribute to organizational effectiveness . . . ."[7] Lieutenant General (Ret) William P. Hallin, a former Air Force Deputy Chief of Staff for Installations and Logistics, echoes the need for information technology to better support logistics outcomes by observing, "Improved logistics data reliability and total asset visibility must be accomplished in the development and enhancement of information systems."[8]

The Air Force must radically improve IT enabling systems and processes that were considered optimal or state-of-the-art when they were first introduced so they continually surpass their initial capabilities. Failing this, two undesirable results occur. First, those producing value (logistics goods and services) will be constrained in achieving their output potential and, therefore, providing customer support and satisfaction. Second, the IT community will be relegated to housekeeping functions vice deploying IT systems giving strength to those in the conference rooms and, more importantly, to those on production floors and flight lines.[9]

Toward that end, the Air Force must simplify its information systems, make them user-friendly and ensure they are customer focused. Second, the Air Force must divest itself of outdated legacy systems and duplicative systems in favor of lean, agile systems that provide producers of goods or services what they need from the information technology arena—when they need it.

Real-Time Information: The Lifeblood of the Warfighter Support System

Many organizations have elaborate control systems that collect more information than the organization can absorb. Often the information collected is needed information but not timely to production activities generating goods and services. Many do not feel notable pressure to significantly alter this situation. Fortunately, others realize they must do something or go out of business. Suffice it to say, the Air Force must transform itself so it does not find itself pushed by some role- or mission-threatening force to change in ways that do not improve productivity and profitability.[10] Instead, the Air Force should move forward voluntarily, internally leading dramatic reform in the area of enabling processes—the focus being improved warfighter support.

According to organizational behavior experts, this approach fits well with what employees want. Whether they are in an environment of change or a stable workplace, employees expect:

- Management to tell them what it will take for the company to succeed and how they fit into the puzzle.
- The organization to provide the financial, physical and human resources needed to do their jobs. [Among the resources expected is a tool box of dynamic IT tools.]
- Honest feedback about their own performance, the performance of their work unit and the performance of the company.[11]

These employee expectations, combined with simplified and dramatically improved information systems focused on helping production activities create value, suggest the need to meld IT with manufacturing technology (MT) to provide timely, sufficient, flexible and cost-effective life-cycle support for military aircraft and engines. In this sense, MT embodies five *interdependent* dimensions:

- Physical Production Processes: Design and layout, type and mix of equipment, movement and flow of people and materials, degree of automation, computer hardware, inspection and simulation.
- Product/Process Design: Planning software to facilitate the design of products, including materials, parts, components and features as well as design processes and their interconnection with products.
- Information Systems: Software for communication, integration and coordination, intelligence and production control.
- Management Technology: *Orgware* that supports the transformation process, including administration, communications, integration, coordination, knowledge capture, learning, process control and rewards systems.
- Product Materials Technology: Core materials, attributes, part interconnection and function.[12]

Value Stream: Activities Increasing Customer Fitness

Enabling communities supporting the logistics community must measure their performance in light of their contribution to their logistics customer's desired outcome. In short, they must map the *value stream* and increase its effectiveness and efficiency. The value stream comprises those specific actions required to bring a specific product (for example, goods, services or both) through any business' three critical management tasks: problem-solving, information management and physical transformation. This includes achieving specific cost, schedule and performance targets and eliminating waste (*muda*).[13]

James P. Womack and Daniel T. Jones, authors of *Lean Thinking: Banish Waste and Create Wealth in Your Corporation*, observed:

> Our initial objective in creating a value stream "map" identifying every action required to design order and make a specific product is to sort these actions into three categories: (1) those which actually create value as perceived by the customer; (2) those which create no value but are currently required by the product development order filling or production systems (Type One *muda*) and so can't be eliminated just yet; and (3) those actions which don't create value as perceived by the customer (Type Two *muda*) and so can be eliminated immediately.[14]

In outlining his views on Agile Combat Support, Lieutenant General Hallin wrote of the need to make such value stream improvements, observing that a responsive logistics system required efficient business-based management and accurate and timely data.[15]

Mr. Marvin Runyon, for 10 years the Postmaster General of the United States, had a complementary vision, which he successfully deployed in the United States Postal Service. Despite the Postal Service's business and operational successes resulting from his leadership, he was "criticized for creating too much of a bottom-line-driven organization."[16] Runyon responded,

> It's not necessarily the bottom line we're driving at. That is one factor. Employee satisfaction is one factor. Customer satisfaction is another factor. We have three voices—the voice of the business, voice of the employee, voice of the indicator [customer] . . . and we measure all of those factors.[17]

The Air Force has these three voices as well.

While employee-indicator development is in its infancy, the effort to develop *customer-focused metrics* was central to a DLA research project by the same name. This effort applied the Pareto principle,[18] which "states that 20 percent of a given product line or population represents 80 percent of an organization's business and impact."[19] This study found "readiness-driving spare parts tend to have very similar logistics characteristics. They are generally higher demand, higher cost parts, with relatively longer procurement lead times."[20] When combined with improved enabling processes in IT and fiscal areas applicable to logistics, this approach can improve warfighter support and satisfaction.

Changing the Status Quo: Curing What Ails You

We often cause our greatest obstacles. We do many things, have numerous IT systems and preserve multiple, if not redundant, IT processes past their useful life. Why? Because they were there when we first got here and now we are comfortable with them—not because they best support future, let alone current operations. Unfortunately, history suggests that we are predisposed to the status quo despite being in an environment in which operations, logistics and business dynamics are moving the Air Force rapidly forward.

> Several years ago *Reader's Digest* ran an interesting story about a woman who, before baking a ham, always trimmed a small amount off each end of the ham. When her young daughter inquired one day as to why she did this, the woman, thinking for a moment, stated that she wasn't certain why, but that she had learned the technique by watching her own mother. She thought it had something to do with making the ham cook more evenly throughout, but she would need to verify this with her mother. When the woman later posed the question to her mother, she was surprised to learn that her mother was not certain either why this was done, but that she likewise had learned the technique by watching her mother, the young girl's great-grandmother. When the occasion arose at a family gathering to ask this question of the great-grandmother, she replied, "The only pan I had available was too small for an entire ham . . . . I always had to trim both ends of the ham to make it fit the pan.[21]

Clearly the young daughter needs to stop unnecessarily trimming the ham. Likewise, the Air Force must cease limiting its logistics value stream because its IT enabling processes and tools do not satisfy today's logistics production requirements. Air Force enabling processes need to change at a rate and to an extent necessary to help logisticians deliver better goods and services to operational customers. As one writer observed:

> Things are moving so fast that if you hold onto your experience too long, you'll get trapped into old ways of looking at things. When you have a paradigm shift, everything goes to ground zero. What does that mean? It's not what you've been taught that matters. It's how fast you can learn. Can you learn faster than the person next to you?[22]

Summary

The Air Force has the capability to dramatically improve the output of its logistics value stream. To do so, it must acknowledge that logistics effectiveness and efficiency are increasingly dependent on high-performing and timely enabling processes. These enabling processes must be designed to best support logisticians who provide value in the form of goods and services delivered to warfighter customers. Once this paradigm shift occurs and bold steps are taken to transform enabling processes to facilitate extraordinary logistics performance, warfighter capabilities will directly benefit from the logistics community's use of these dramatically improved support multiplier processes.

Notes

1. Editors of *Loglines, Loglines*, Vol. 3, No. 4 and Vol. 4, No. 1, 3.
2. Morrill, Arthur B. III., "Lean Logistics: Its Time Has Come," *Air Force Journal of Logistics*, Vol. XVIII, Nos. 2 & 3, 8-9, 15.
3. Address by Brigadier General Thomas A. O'Riordan (USAF), Vice Commander, Ogden Air Logistics Center, to the 1998 Maintenance Officer Association Annual Conference.
4. Roberts, Lon, "Process Reengineering: The Key to Achieving Breakthrough Success," Milwaukee, Wisconsin: ASQC Quality Press, 1994, 21-22.
5. *Ibid.*, 2-3. See also Michael Hammer, "Reengineering Work: Don't Automate, Obliterate," *Harvard Business Review* 68 (Jul-Aug 90), 104.
6. Giffi, Craig, Aleda V. Roth and Gregory M. Seal, *Competing in World-Class Manufacturing: America's 21st Century Challenge*, Foreword by Thomas J. Murrin, Deputy Secretary, U.S. Department of Commerce, Homewood IL: 1990, 16.
7. Reeder, Franklin S., "IT Managers Missing Their Cue," *Government Executive: Government's Business Magazine*, May 1998, 59.
8. Hallin, William P., "Agile Combat Support—The New Paradigm," *Air Force Journal of Logistics*, Vol. XXII, No. 3&4, 2.
9. "Competing in World-Class Manufacturing," 16, 73.
10. *Ibid.*, 45, 224.
11. *Ibid.*, 257.
12. *Ibid.*, 303.
13. Womack, James P. and Daniel T. Jones, *Lean Thinking: Banish Waste and Create Wealth in Your Corporation*, New York: Simon & Schuster, 19, 37-49. "Kaizen is a system of improving processes and activities up and down the company hierarchy by involving everyone from top managers to the lowest level employee, working together in a team. It is the Japanese term for continuous-improvement activity and is considered by many observers as a modern total quality management philosophy. This philosophic approach consists of applying small but continuous incremental efforts to improve any activity. In contrast to business process reengineering, the results from developing and implementing a kaizen system are not major reorganizations nor replacements of processes by new ones but are steady incremental improvements to existing processes. The goal of kaizen is to eliminate the three M's. Muda means useless, excess or any activity that does not add value; for instance, a worker looking at an automatic machine does not add any value." Nia, Myriam. "Kaizen" n.

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View Towards Change: The United States-Republic of Korea Arms Trade Relationship Through the Post-Cold War

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In May 1998, Deputy Secretary of Defense John Hamre ordered an extensive review of the Pentagon's foreign military sales (FMS) process.[1] The impact of this review could result in the dismantling of an empire of bureaucracy that evolved during the Cold War. The review was brought on after complaints from senior officials and an apparent realization that the cumbersome FMS process, a legacy of Cold War-era US security assistance, was driving US allies to other suppliers of military goods and services who are willing to deal more flexibly. There is perhaps no better example that demonstrates the need to develop a more productive course in arms trade relations than that involving the United States and the Republic of Korea (ROK).

Since the end of World War II, the ROK and the US have shared a strategically significant economic and military relationship marked by strong political ties and mutual amity. An important aspect of this relationship has been a steady stream of military hardware and assistance from the US. Military assistance and weapons sales from the US have served as a protective bulwark against North Korean communist aggression and as a facilitator of sustained economic growth and prosperity. However, the dissolution of the Soviet Union has ushered in a new era. For the ROK, supplier options have substantially increased since the collapse of Soviet communism and subsequent emergence of Russia as an international arms competitor. As a result, new markets have been created outside of the traditional US-ROK arms trade arrangement, and fresh opportunities have presented themselves to the ROK in the form of inexpensive weaponry and tempting transfers of technology.

The purpose of this article is to provide the reader with a detailed understanding of the US-ROK arms trade relationship. Through an understanding of this relationship, a reference for policy can be set and a productive course for future dealings with an important ally can be undertaken. In order to provide a clear understanding of the US-ROK arms trade relationship, the article will first introduce Korea. Following this introduction, a historical explanation of the evolution of the US-ROK relationship and the ROK defense industry will be provided. This explanation will culminate in a brief case study involving a major ROK offshore defense acquisition that embodies the beginning of a new era in the US-ROK arms trade relationship.

Korea: A Brief Background

As a nation, Korea has a long and unfortunate history of foreign domination and exploitation. A brief historical examination of attempts by foreign invaders to usurp Korea's sovereignty clearly illustrates a need for armed defense. A Korean proverb roughly translated as "The backs of shrimp break when whales fight" describes the plight of Korea. Sandwiched tightly between what are today the People's Republic of China (PRC), Russia and Japan, Korea served for "thousands of years as a convergence point of surrounding powers, attracting covetous attention and periodic invasions."[2] Japan, the Mongols, the Manchus and China's Han, Liao, Yuan, Chin and Ch'ing dynasties had all invaded Korea at one point or another before the 20th century.[3,4]

The 20th century has seen the nation of Korea fought over during the Russo-Japanese War of 1904-05, annexed by Japan in 1910 and subsequently colonized until 1945. Although Korea was liberated by Russian and US forces in 1945, liberation was accompanied by immediate separation at the 38th Parallel into two halves. The two halves, North Korea and South Korea, have been pitted against each other, more or less, since 1945. Since the division of the Peninsula in 1945, there has been constant military tension between the North and South. At times, North Korea has "stepped up its military hostility through a series of bold provocations."[5] Thus, in South Korea's case, the threat has been real, and the need to defend itself has been quite urgent at times.

Republic of Korea and the United States: Beginnings of a Strategic Relationship

On 15 August 1945, Colonels Dean Rusk (later to become Assistant Secretary of State for Far East Affairs, 1947-1960, and Secretary of State, 1961-1969) and Charles H. Bonesteel were ordered by the American War Department "to withdraw to [a room with a map] and find an appropriate place to divide Korea."[6,7] It was shortly after the Japanese defeat in World War II that US military involvement began in Korea with the arrival of the US 7th, 40th and 6th Infantry Divisions at the Port of Inchon during the month of September 1945.[8] The first mission carried out by US forces was to receive the Japanese surrender and create a South Korean internal security force. US General Order No. 1 called for the US to accept Japanese surrender in Korea south of the 38th Parallel and for the USSR to accept surrender north of it. The Soviets, who had arrived in Korea 1 week earlier went along with the terms of the order.

With the approval of General Courtney H. Hodge, the Commanding General of US Army Forces in Korea, the National Constabulary was established under the US military government in the area south of the 38th Parallel on 15 January 1946.[9,10] The Constabulary served as the core nucleus from which the National Defense Forces were created on 15 August 1948 when the Government of the Republic of Korea was first inaugurated.[11]

When war broke out on the Korean Peninsula on 25 June 1950, ROK forces were ill-prepared. Poorly equipped and barely trained, ROK forces were initially caught off guard and nearly decimated by the North Korean onslaught. Within 2 weeks of the surprise attack, President Harry S. Truman authorized US air, naval and ground forces to intervene on the side of South Korea.[12] After 2 years of bitter negotiations and seesaw battles, "the UN Command finally managed to sign an armistice agreement with the communist side," the Democratic People's Republic of Korea (DPRK) and their ally, the People's Republic of China, on 27 July 1953.[13]

The aftermath of the Korean War reestablished the 38th Parallel as the demarcation line dividing the communist-backed DPRK and US-supported ROK. Initially, ROK forces were completely dependent on the United States for all forms of military support:

> Due to the lack of modern equipment and leadership . . . the ROK military required consistent assistance from the United States. The US Army transferred essential military items, vehicles, ammunition, fuel, and replacement parts and turned over all its inventory to the ROK Army after the war. Even supplies such as clothing and consumables were provided by the US military.[14]

In order to thwart further communist encroachment, the ROK would remain solely dependent on the United States for various forms of military assistance until the early 1970s.

Prompted by the Nixon Doctrine and the subsequent decision in December 1971 by the US to withdraw the 7th Infantry Division, the ROK Government proclaimed a *state of national emergency* and embarked on the development of an indigenous defense industry.[15]

Beginnings of the ROK Defense Industry

Weapons production for the ROK Army actually began in 1971, "when a memorandum of agreement between the US and the ROK authorized the Ministry of National Defense to construct a plant to assemble US-designed Colt M-16 rifles."[16] In 1973, the ROK Government enacted the Law on Military Supplies in which "various measures were taken to foster and support defense industries."[17] Steps included in the act were creation and operation of a support fund, provision of subsidies, taxation privileges, contractual favors and a defense fund-raising drive. Shortly after the fall of South Vietnam in 1975, the defense tax system was introduced to accelerate the development of domestic defense industries. By the mid-1970s, the ROK Government had "signed agreements to begin licensed production of many types of US-designed weapons, including grenades, mortars, mines, and recoilless rifles."[18] In addition, the ROK began to manufacture ammunition for the weapons it produced for the army.

In 1976, under the Korea Defense Industry Promotion Act, the ROK Government established the Korea Defense Industry Association for the purpose of promoting local manufacture of weapons.[19] Since that time, Korean manufacturers have seized an ever-increasing portion of their defense pie.

The ROK's pursuit of domestic production continued to develop throughout the 1970s. In 1978, the ROK "successfully developed missiles and multi-firing rockets."[20]

Also in that year, preparations were completed for the indigenous production of M-48A3 and M-48A5 tanks. The 1980s brought closer military ties with the US, and the ROK was able to focus comfortably on conventional weapons improvement and expanded research and development. A South Korean-built destroyer, the *Ulsan-ham*, was put into service in March 1980. In 1982, the year in which the Second Force Modernization Program was launched, the ROK began producing F-5F fighter-bombers in a joint venture with the US contractor Northrop.

"By 1990, ROK army contracts were being awarded to South Korean companies to produce tanks, self-propelled and towed field guns, armored vehicles, and helicopters."[21] These contracts included indigenous production by Hyundai of the *88* Tank, formerly the *K-1* (the *K-1* was a joint US-ROK design). The contracts also included co-production activities, as in the co-production of H-76 helicopters by the Sikorsky Aircraft Corporation and the South Korean firm Daewoo.

The 1990s brought less ROK dependence on the United States for defense support and assistance. The bilateral and multilateral defense agreements that defined the parameters of the Cold War underwent tremendous change. In an effort to diplomatically envelop North Korea, the ROK initiated diplomatic normalization with the PRC and the Soviet Union in 1989 and 1990, respectively. The collapse of the Soviet Union in December 1991 brought an end to the Cold War bipolar framework. No longer constrained by years of traditional bipolar arrangements and treaties, the ROK found itself in a better position to view internal weapons development and procurement issues with a sharper focus on their own national interests.

Unlike Europe, however, the 1990s have not shown signs of a qualitative transformation in the bilateral military alliance structures in Northeast Asia. The US is maintaining a constant force structure in Japan and the ROK despite rapprochement with the PRC and Russia. It is the potential for change in these bilateral alliances (between the US and its Northeast Asian allies) that is "forcing each country in the region to rethink its own requirements for ensuring security and promoting national interest."[22]

The ROK in the Post-Cold War

In its *ROK Policy on National Defense*, distributed through the Embassy of the Republic of Korea in Washington DC, the ROK has recognized the need for close military cooperation between "neighboring countries to maintain the perception of regional stability and peace."[23] Unthinkable a decade before, the 1990s have seen the ROK begin intermilitary exchange and cooperation with Japan, the PRC and Russia. In a move to build confidence in a budding ROK-Japan military relationship, the ROK executed a Letter on the Prevention of Accidents Between Korean and Japanese Military Airplanes effective 5 June 1995. During the Russian defense minister's visit to the ROK in May 1995, the two countries signed agreements and a memorandum of understanding on military exchange for 1996-97 signifying that the *two nations'* military relationship has entered the phase of practical cooperation. After the ROK set up a defense attaché office in the South Korean Embassy in Beijing in December 1993, the PRC followed with an office in the Chinese Embassy in Seoul in 1994. At a senior working-level officials meeting held in February 1995, the two countries agreed to gradually expand military exchanges in the future. The ROK has clearly demonstrated its desire to more independently determine the direction of its military policies.

From the perspective of arms sales and transfer of weapons technology, the US-ROK relationship is at an important juncture, caught up in the complex and rapidly changing geopolitical environment that is currently shaping the world. For many years, the ROK and the US shared a common goal of thwarting communist expansionist plans; the US in a global context, and the ROK in a more focused, regional context. The ROK's commitment to deter North Korean attack parlayed into a larger and, because of the nuclear question, more menacing global conflict between the US and Soviet Union. Considering this and the pace at which the ROK was developing its own indigenous defense industry, reliance on US weapons and technology by the ROK was a given.

The end of the Cold War lessened the overarching potential for global conflict between the US and Soviet Union, at a point when, for the first time in recent history, the ROK was being taken seriously by its regional neighbors as an economic power. This was vividly portrayed in 1990, when Seoul agreed to lend the ailing, former Soviet Union \$3B in cash and goods. After giving the Russians \$1.47B, the ROK halted further disbursement in 1992 when Moscow failed to meet interests payments.[24]

Meanwhile, in 1993, "Russia set up its state-owned military marketing corporation, Moscow-based Rosvoorouzhenie," and began targeting the countries of the Far East and Southeast Asia.[25] By 1994, Russia had made itself a significant supplier of equipment and weapons to the ROK.

Since 1994, Seoul has purchased about \$250M in tanks, armored personnel carriers and weaponry in an arms-for-debt barter deal with Russia. This arrangement has spurred the chagrin of US Government and industry officials who emphasize the need for interoperability between the allies on the Korean Peninsula. Moreover, South Korean Air Force officials said they would include Russian SU-35 and SU-37 fighter aircraft in their estimated \$9B FX next generation fighter competition.[26]

As a way to recoup the overdue Russian debt, the ROK agreed in 1995 to accept Russian defense equipment.[27] Initially, the ROK agreed to receive about half of a \$457M overdue installment that came due in 1993 in the form of weapons, with the other half in raw materials and civilian helicopters.[28] Pavel Fitin, deputy head of the South Korean department in Russia's foreign Economic Relations Ministry, spoke on the issue, saying that the agreement signed by the two countries on 10 July 1995, "is completely satisfactory for the Russian side [however] . . . we'll do our best to increase the arms share in [future] agreements."[29]

The Case of the SAM-X Project

On 8 October 1997, in an apparent effort to lessen public fear over a potential North Korean Scud missile attack, ROK Air Force (ROKAF) Chief of Staff Lee Kwang-hak announced the ROKAF would establish an early warning alarm system by December of the same year. He also stated he was aggressively promoting the introduction of short-distance radar bases and a next-generation surface-to-air missile defense system, known as the SAM-X project.[30] In order to achieve this capability, the ROK would have to either develop it indigenously or turn to the international arms market and select an appropriate arms contractor.

The ROK announcement of the SAM-X came on the heels of a major blunder in executing the nation's air-raid warning system. On 23 May 1996, a North Korean pilot defected to the South in his MiG-19. As the fighter was tracked nearing the DMZ, air-raid sirens wailed in all the appropriate towns and cities, except Seoul, South Korea's capital. Evidently, the director of the warning center responsible for Seoul had ordered the system shut down a year before because of faulty operations. The mayor of Seoul publicly apologized for the incident, and prosecutors immediately sought the arrest of those thought responsible for the deed.[31] Shortly thereafter, in September 1996, a North Korean submarine slipped into South Korean territorial waters undetected and accidentally ran aground. For 49 days, North Korean commandos who had infiltrated South Korea via the submarine ran amuck, prompting a massive manhunt. Seventeen South Koreans died in the ordeal, while ROK military and police managed to kill 13 commandos and capture 1.[32] A few months later, the most significant North Korean defector to have ever fled to the ROK, Hwang Jang Yop, would tell of a vast network of North Korean spies in the South and that North Korea had nuclear and chemical weapons capable of *scorching* the South.[33] For these reasons, considerable pressure began mounting on the ROK Government regarding the country's system of defense. Although the North Korean ballistic threat had been around since the late 1980s and a possible nuclear threat was known by the early 1990s, it was not until 1997 that South Korea formally announced plans for the SAM-X project. Apparently, the ROK had been counting on developing an indigenous SAM capability to deal with the North Korean threat. However, after a series of security breaches occurred in South Korea, the ROK Government took more aggressive steps to quell mounting fears. The announcement of the SAM-X project appears to have been one of those steps.

The case of the SAM-X project represents a watershed event in the US-ROK arms trade that highlights the ROK's desire to wield independent discretion in its defense acquisition policy. The project requires a sophisticated state-of-the-art missile defense system, the likes of which the ROK would have to purchase from an offshore supplier. Raytheon's Patriot PAC2 missile system had already been introduced to the ROK in 1994 under the control of the US Eighth Army as a way to protect US forces stationed in South Korea at a time when tensions and rhetoric were particularly heightened on the Korean Peninsula. This put Raytheon in what one would think to be a favorable position to deal directly with ROKAF and ROK Government officials with the hopes of concluding a major weapons sale. At the same time, however, Russia had been eyeing the potential sale as an opportunity to pay off its remaining debt to the ROK. Through their state-run weapons export company, Russia offered their S-300V ground-based air defense system.[34] When the ROK entertained the option of either going with the Russian system or the US-made Patriots, controversy erupted. Unlike the past, the US was now a *contender* for an estimated \$1B contract for a weapons system in the ROK. When asked about the issue during a trip to Asia, US Defense Secretary William Cohen voiced apparent opposition, warning that a decision in favor of the Russian system ". . . would not play well in Congress at all." He added, "It would not be a good deal, I think, overall ultimately for our relationship. It's important that they [the

ROK] stay with US equipment."[35] Russian response to this was defensive and accusatory. After noting that a contract in Russia's favor would be a good method to pay back some of Russia's overdue debt to the ROK, the Russian ambassador to the ROK, George F. Kunadze, accused Secretary Cohen of "bullying a customer into buying merchandise."[36] Although Secretary Cohen's remarks were arguably rooted in concerns regarding interoperability issues, they were politicized nonetheless by both the ROK and Russia as remarks intended to discourage the ROK from concluding this particular arms deal with the Russians.

Immediate public reaction in the ROK appeared to side with the Russians. ROK Government officials, acutely aware of the importance of public opinion in an increasingly democratic South Korea, seemed caught between public sentiment and foreign diplomacy. As of this writing, the ROK Government is withholding a decision as to which system to purchase. The decision that the recently elected government of Kim Dae-Jung makes on the issue could potentially change the course of a long-standing and stable defense relationship dominated by US doctrine, strategy, leadership and technology. Regardless of the ROK Government's ultimate decision, a markedly changed US-ROK relationship has emerged with regard to the arms trade.

Conclusion: Rethinking the Arms Trade Relationship in the Post-Cold War

The dissolution of the Soviet Union and subsequent end of the Cold War has drastically changed the structure of the international arms market. The most glaring aspect of the SAM-X case is that it involves dealings between parties that only a decade ago would have been unimaginable. The notion of the ROK snubbing the United States and turning to Russia for a major arms deal would have been, indeed, unthinkable. However, the end of the Cold War has allowed countries to openly engage Russia. During the Cold War, economic dealings with the Soviets, especially the purchase of weapons, would have signaled an ideological shift and an almost certain swift and harsh response from the United States. Russia, unlike before, is now a viable source of weapons for the ROK to consider when making an offshore purchase. It is also a debtor country to the ROK that has pushed the idea of repaying its debt in the form of weapons and weapons technology transfer. Thus, unlike the loyalties that were built up during the Cold War, the post-Cold War period has brought with it the opportunity for the ROK to think beyond the US-ROK relationship and begin planning for its future in Northeast Asia. Issues such as reunification with North Korea, trade relations with the PRC and military exchanges and cooperation with Japan, Russia and the PRC have taken on great significance in the ROK.

The bilateral mechanisms developed during the Cold War on the Korean Peninsula are still in place, but the respective goals pursued by the US and ROK no longer fit the Cold War scheme. The ROK may have national plans that no longer fit into the bilateral framework that evolved during the Cold War. The case of the SAM-X shows that ROK leaders have responded to ROK public opinion, risked offending the United States and put their national agenda ahead of US-ROK relations.

For these reasons, the classic supplier-recipient relationship is no longer a viable framework from which to view the relationship. The relationship shared by the US and the ROK vis-a-vis weapons procurement can be characterized as one that has taken on more of a customer-supplier orientation. The ROK now behaves much like the customer who shops in an unrestricted market looking for the best product at the best price. With the Cold War over and traditional bilateral arrangements no longer available to fall back on, the US must aggressively seek ways to promote sales and stay in business, much like the merchant. If the US desires to maintain a continued competitive edge in the ROK arms market, greater attempts at win-win arrangements are likely to be necessary. Efforts by the US Government to ease the FMS bureaucracy as directed by Deputy Secretary of Defense Hamre may be the essential first steps required to allow this to happen.

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A Comparison of Air Force Organic Airlift and Commercial Air Express Distribution Performance

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Introduction

With the end of the Cold War and the resulting decline in the military budget, the Department of Defense (DoD) must now rely on a logistics system capable of supporting a smaller, highly mobile and advanced-technology force with more flexible and responsive processes at a lower total cost. In response to this shift from the traditional mass logistics paradigm of holding large inventories, the 1996 edition of the DoD Logistics Strategic Plan highlighted the need for a restructured logistics system. The plan identified two desired outcomes of restructuring logistics: " . . . better, faster and more reliable and highly mobile response capability and a leaner infrastructure that better balances public/private capabilities."[1] To this, the Services and joint community responded with such programs as Lean Logistics, Total Asset Visibility, Velocity Management and Focused Logistics. Today, within the Air Force we see programs such as Agile Logistics and Agile Combat Support.

As military budgets declined, most of the initiatives to improve responsiveness and reduce total costs focused on reducing logistics delivery or pipeline times. The emphasis on reducing pipeline time is not unwarranted. A 1990 Air Force Logistics Command analysis indicates that a 1-day reduction in pipeline time could reduce inventory costs by $16M to $25M annually.[2] Another study indicates that a day of pipeline costs saved for all DoD customers translates into nearly $100M less in inventory stock the DoD must purchase.[3]

With fewer defense dollars, it is imperative the Air Force reduce overall logistics costs while maintaining appropriate levels of mission capability. Today, and for the foreseeable future, the Air Force has a widening range of choices in commercial transportation services to evaluate when managing military logistics and distribution processes. Significant improvements, most notably in information technology and global expansion over the last two decades, may allow commercial transportation carriers to provide faster delivery times at lower total cost. The aforementioned importance of reducing delivery times warrants more research concerning the benefits of using commercial transportation services for military cargo.

The main objective of this research is to determine if commercial express carriers have a significantly shorter total pipeline time than Air Force organic transportation systems. If commercial carriers are faster, the second objective is to ascertain which portions of the Air Force transportation pipeline cause delays when compared to the equivalent portions of the commercial carrier pipeline. To narrow the scope of the research, the study focuses on the airlift of high-priority cargo via commercial express and organic transportation from various supply points in the United States destined for Spangdahlem Air Base (AB), Germany.

Background

The Air Force uses the Uniform Materiel Movement and Issue Priority System (UMMIPS) to establish priorities and movement time standards for all cargo. The priorities defined and the time standards established apply to any given segment of the order and ship pipeline from the depot to base level. The time standards are in calendar days and represent the maximum amount of time that should elapse during any given pipeline segment for items that are in stock. Priority designators are determined from the Force/Activity Designator (FAD) code assigned to the requesting unit and the Urgency of Need Designator (UND) specified by the requester. Priority designators are consolidated into priority groups and time standards are given for each priority group in each segment of the pipeline.

Under UMMIPS, the oldest requisition within the highest priority group is put at the top of the priority list. Once the priority is established, DoD organizations have several options when deciding on the most appropriate mode of transportation to meet the UMMIPS time standards, maintain mission readiness and limit logistics costs. Military organizations located overseas have traditionally relied on the Air Mobility Command (AMC) to move priority cargo; however, commercial express carriers are now readily available to transport military cargo.

In addition to the priority of the cargo, the structure of the logistics pipeline itself has a major impact on delivery time. In the Air Force, a logistics pipeline is composed of many steps depending on the type of materiel being requisitioned, its source and destination. High-priority aircraft replacement parts generally originate from depots or Air Force bases and are airlifted via organic military airlift or express commercial airlift to a destination. Several organizations may get involved depending on the route of the materiel. The originating and terminating traffic management offices, supporting ground transportation and AMC aerial port organizations may contribute to the movement of the requisitioned item. If commercial airlift is used, the item may move from an origin location to a destination without any

	MEAN	MEDIAN	MODE	STANDARD DEVIATION	VARIANCE	OBSERVATIONS
ORGANIC	6.86 ($\bar{x}_1$)	6	5	6.21 (s_1)	38.56 (σ_1^2)	545
FEDEX	2.77 ($\bar{x}_2$)	3	2	1.11 (s_2)	1.24 (σ_2^2)	144

Table 1. Total Transit Time[8]

military organization involvement. A combination of AMC organic and commercial service is possible as well.

Several major differences exist between AMC organic airlift and commercial airlift. Foremost, AMC airlift is centered around channel service. A channel is a regularly scheduled mission over a fixed route with capacity available to all customers. A monthly schedule is published for both passenger and cargo channel missions, and a priority system is used to allocate airlift resources where demand exceeds AMC capabilities.

In contrast to military organic transportation, express commercial carriers—such as Federal Express (FedEx), United Parcel Service, Airborne Express and Emery—are more responsive to customer demands and are able to adjust flight schedules and airlift capabilities on a daily basis if necessary. According to the Program Management Advisor for FedEx, they are able to fly an additional aircraft with only a few hours notice if necessary to ensure the on-time arrival of cargo.[4] Commercial express carriers have structured their business practices to ensure speedy, reliable and flexible delivery.

The capabilities of commercial express carriers have led some to believe airlift of high-priority cargo should be outsourced to the private sector to reduce logistics pipeline times, inventory levels and overall logistics costs. World Wide Express[5], the latest plan to outsource more airlift to express carriers, is expected to transfer approximately 40 percent of the cargo now being transported by AMC to commercial express carriers.

Data Collection

The primary source of data collection for organic transportation was the Air Force Traceability and Cargo (ATAC) system. Because of the scope and limitations of this study, the only data selected for analysis were high-priority cargo shipments identified by 777 and 999 priority codes destined for Spangdahlem AB. Five months of pipeline transit times were collected (1 December 1995 through 30 April 1996) for a total of 533 shipments. Transit times for engines, hazardous cargo and classified materiel were not analyzed since these items are not shipped via express carriers.

To make comparisons with organic transit times, commercial transit time information was needed. FedEx was chosen to represent commercial carriers because they transport the majority of commercially carried cargo bound for Spangdahlem AB.[6] Unfortunately, collecting this data proved to be difficult. The ATAC system could not provide adequate commercial data for the 5-month period. In an attempt to obtain data, FedEx was contacted, but they indicated they could not provide the information for the specific time period. Their system purges the data after 30-60 days and the test period was much older than 60 days from the date of request.[7] Instead, they provided shipment data for the month of February 1997 for 144 shipments. It was felt there were no significant differences between the two time periods that would invalidate the organic and commercial comparisons.

Results and Discussion

Using the data provided by FedEx and Air Force organic data, descriptive statistics were computed as shown in Table 1. In order to determine the possibility of outliers in the data, frequency distributions for FedEx and organic shipments were created. They are shown in Table 2.

Noting the significant variance attributed to the overall organic shipment times (Table 1) and dispersed frequency distribution in Table 2, a Box and Whisker Plot[9] and Stem and Leaf Plot[10] were used to determine any probable outliers for possible elimination from the statistical tests for both the organic and FedEx data. Based on the results of both plots, the data eliminated as probable outliers from organic shipment information were those in which total shipment time exceeded 20 days. The 11-day shipment time in the FedEx data was also considered an outlier and eliminated. The outliers for each set of data were eliminated because they were not regular occurrences and did not indicate a constant problem. After

# DAYS	FEDEX	%	CUMUL	ORGANIC	%	CUMUL
1	1	0.7	0.7	0	0.0	0.0
2	68	47.2	47.9	13	2.4	2.4
3	51	35.4	83.3	14	2.6	5.0
4	20	13.9	97.2	76	13.9	18.9
5	1	0.7	97.9	125	22.9	41.8
6	1	0.7	98.6	121	22.2	64.0
7	1	0.7	99.3	80	14.7	78.7
8			99.3	34	6.2	85.0
9			99.3	16	2.9	87.9
10			99.3	23	4.2	92.1
11	1	0.7	100.0	14	2.6	94.7
12				6	1.1	95.8
13				4	0.7	96.5
14				1	0.2	96.7
15				0	0.0	96.7
16				3	0.6	97.2
17				0	0.0	97.2
18				2	0.4	97.6
19				1	0.2	97.8
20				1	0.2	98.0
21				3	0.6	98.5
22				1	0.2	98.7
23				2	0.4	99.1
24				2	0.4	99.4
33				1	0.2	99.6
81				1	0.2	99.8
104				1	0.2	100.0
TOTAL	144	100.0		545	00.0	

Table 2. Frequency Distribution of FedEx and Organic Shipments

elimination of outliers from both sets of data, 97.8 percent of the original data and 99.3 percent of the FedEx data were still intact for statistical comparison. The derived descriptive statistics for the remaining data are shown in Table 3.

Statistical analysis using the standard *z* statistic[11] indicated a significant difference between the two mean delivery times at an alpha level of less than .01. A two-tailed test indicated the mean military pipeline time was significantly greater than that of FedEx. Total pipeline time for the military organic system was more than 3.5 days longer on average.

After determining there was a significant difference between Air Force organic and FedEx movement times, the next step was to determine which segments of the transportation pipeline exhibited differences between the two systems. The transportation pipeline segments for each system are shown in Table 4.

Table 5 shows the average times for each segment of the pipeline. Segment 1 was significantly longer for the organic transportation system (1.74 days) than for the commercial system (0.27 days). The comparison is between FedEx average transit time to move items from military supply depots to Memphis, Tennessee (MEM-FedEx hub) and the average transit time of carriers to transport items from the depots to Dover AFB, Delaware (the Air Force aerial port of embarkation [APOE] for this study).

According to an Air Force Materiel Command (AFMC) representative, an average of 1.74 days for this segment is not an unreasonable transit time for organic transportation.[12] After a Materiel Release Order (MRO) is issued at the depot, the transportation organization at the depot prepares the item for shipment and places it in a carrier's bin. A carrier's representative then arranges the cargo pickup for onward movement. This pickup could occur on the same day if the MRO was issued early enough in the day, which is often the case, since carriers schedule several pickups from the depots daily. When this happens, the item would be delivered the next day at Dover AFB—thus incurring a 1-day delivery period. However, if the MRO was released late in the day, the item would not be picked up until the following day. It would then be delivered to Dover on the second day after the MRO was issued—thus incurring a 2-day delivery period. Another consideration for this segment period is the inclusion of weekends. FedEx and other carriers do not deliver on weekends. An item picked up on Friday will not be delivered until Monday. This commercial practice obviously increases the average time for this segment. The AFMC depot ships the items as soon as possible after receiving the shipment notice without regard to flight schedules at the APOE.

One way to reduce this segment of the organic system entails releasing items for shipment at the depot so they could be picked up by the carrier that same day and delivered the next day. However, since this is only a time-accounting tactic, it would not affect the overall shipment time from the customer's perspective.

Segment 2 of the pipeline consists of the port hold and handling time at the APOE—the Dover AFB aerial port for the organic system and Memphis, Tennessee, for FedEx. This segment is also statistically longer for the organic system, taking about 2 days at Dover and about 4.5 hours at Memphis. AMC records confirm this finding. They indicate Dover's port hold time for high-priority items during 1996 was 48.5 hours. At that time, one C-5 and one KC-135 flew daily channel missions from Dover AFB to Ramstein AB, Germany, and the port received about 1,000 packages from express carriers daily. The small express packages, generally delivered by 12:30 p.m. to the port, were immediately in-processed and placed on pallets for loading on a KC-135 that departed at 4:45 p.m. However, large and outsized priority cargo could not be placed on a KC-135 because of the cargo hold size restrictions of the aircraft. These items, such as an F-15 wing, could wait 3-4 days in the port for space on a C-5 aircraft. Another problem that extends port hold time is the unreliability of the C-5. Too many times, cargo is delayed at the port simply because the aircraft breaks and cannot be transported until the aircraft is repaired. Beginning on 10 June 1997, the C-5 was replaced with the more reliable, yet smaller, C-17 to lessen this problem. Thus, the longer port hold time is in part due to the large items that FedEx refuses to carry, which must be stored at the APOE until space on a large military aircraft is available. One way to reduce this segment of the organic system would be to schedule both the KC-135 and the C-5 or C-17 after the FedEx delivery each day. Then, the high-priority items could be immediately placed on a departing aircraft that day.

	MEAN	MEDIAN	MODE	STANDARD DEVIATION	VARIANCE	OBSERVATIONS
ORGANIC	6.24 ($\bar{x}_1$)	6	5	2.39 (s_1)	5.72 (σ_1^2)	533
FEDEX	2.71($\bar{x}_2$)	3	2	.88 (s_2)	.77 (σ_2^2)	143

Table 3. Total Transit Time After Removal of Outliers

SEGMENT	1	2	3	4	5	TOTAL
ORGANIC	Depot ship to APOE Receipt	APOE Receipt to APOE Ship to APOD	APOE Ship to APOD Receipt	APOD Receipt to APOD Ship	APOD Ship to Final Receipt	Total Ship Time
FEDEX	Origination to Receipt at MEM Hub	MEM Receipt to MEM Ship to FRA	MEM Ship to FRA Receipt	FRA Receipt to FRA Ship	FRA Ship to Final Receipt	Total Ship Time

Table 4. Pipeline Segments

APOE: Aerial Port of Embarkation
APOD: Aerial Port of Debarkation
MEM: Memphis, Tennessee
FRA: Frankfurt, Germany

SEGMENT		1	2	3	4	5	Total
ORGANIC	MEAN	1.74	1.96	0.41	0.39	1.73	6.24
	STD	1.35	1.16	.90	0.51	1.71	2.39
	VAR	1.83	1.36	.81	0.26	2.94	5.72
FEDEX	MEAN	0.27	0.19	0.50	0.29	0.33	2.77
	STD	na	na	na	na	na	1.11
	VAR	na	na	na	na	na	1.24

Table 5. Computations for Total Pipeline and Segment Times (in days)[13]

Segment 3 consists of the comparison between the average flight time from Dover AFB to Ramstein AB and the average flight time from Memphis to Frankfurt, Germany. Not surprisingly, there appears to be no significant difference in average flight time between the two systems.

Segment 4 is the port hold time at the aerial port of debarkation (APOD) for the military organic system and at Frankfurt for FedEx. For the organic system, port hold time begins when the aircraft officially lands (block time) and ends when the shipment is processed into the Consolidated Aerial Port System. For FedEx, it is the time between check-in of the package until release for movement to Spangdahlem AB. As in the case for segment three, there does not appear to be a significant difference between the two systems.

Segment 5 of the system is the transportation time between the APOD (Ramstein AB for the organic system and Frankfurt International Airport for the commercial system) and the Spangdahlem AB supply office. Once again, time for the organic system is significantly longer than it is for the commercial system. The cargo is trucked from the APOD to Spangdahlem for both systems. The drive is approximately 4 to 6 hours. The commercial system averages about 8 hours for this segment while the organic system averages about 1.73 days. For the organic system, the Army's 28th Transportation Battalion picks up a truckload every day from the aerial port and delivers the cargo to Spangdahlem.[14] One possible cause for the delay is when there is more than one truckload of cargo the excess may have to wait 1 or more days to be delivered to Spangdahlem. Another possible cause is when the cargo arrives after the truck departs for Spangdahlem. Thus, the cargo would wait 1 day for surface transportation. These two possibilities could combine to create the large average segment time seen. The obvious solution to this problem is to schedule the departure of the truck after aircraft have arrived and been downloaded. Additionally, if one truck cannot handle all of the Spangdahlem cargo, then arrangements for an additional truck should be made prior to arrival of the shipment.

Conclusion

The primary purpose of this research was to determine if commercial carriers deliver military cargo originating in the Continental United States to Spangdahlem AB, Germany, faster than the military's own organic pipeline. Since the total time was longer for military organic systems, the second objective was to determine which portions of the military's transportation pipeline cause the delay in delivery time. The primary conclusion drawn from this research is commercial carriers are, indeed, able to transport small items (weighing less than 150 pounds) to Spangdahlem AB faster than the military's traditional organic transportation system. A secondary conclusion taken from this research is that every segment of the pipeline, except the actual flight time between the US and Europe (Segment 3) and the port hold time (Segment 4), is longer for military organic transportation.

There are several other points made in this research. The first is that organic transportation is not the cause of longer organic pipeline time. When, as with the proposed World Wide Express system, the decision is made to substitute the commercial sector for organic logistical functions, it is not more efficient transportation that is being sought. Rather, when DoD utilizes FedEx, it is purchasing the logistics network and not simply transportation. Unfortunately, when one hears complaints voiced comparing AMC to the commercial sector, the impression is that transportation is the weak link.

The problem with making this assessment is that attention is misdirected from the actual problem and potential solutions. It is the network that is inefficient, and particular pipeline segments seem to be the culprit. Thus, prior to simply outsourcing or privatizing with commercial firms, research should be undertaken to see if the organic pipeline can be modified to achieve the desired level of service for less cost than FedEx. Some potential modifications were offered that require little or no cost, such as better coordination with the Army surface transportation at the destination. Another potential cause for increased organic pipeline time may be the result of how the organic shipment is recorded as being delivered. If shipment delivery information is entered into the system in a batch mode at the destination, then depending on when the shipment arrived and when the information is entered into the computer, a discrepancy of several days could exist. If the item arrived on a Friday afternoon but was not recorded until Monday, an extra 3 days would be indicated on the official record. This does not happen with FedEx or other commercial carriers because they require a signature prior to releasing their shipment, and the time of the signature determines their official recorded delivery time. In reality, there may be one or two *phantom* days in the organic pipeline delivery time. Requiring organically delivered items to be recorded upon receipt is a costless way to decrease both the mean delivery time and variance, assuming this situation exists.

Better coordination between AMC and the Army, in terms of trucks and capacity needed at the destination, as well as when they are needed, would seem to be a relatively free improvement or one with little cost. The same may be true of coordination between AMC and the depots. Although the depot metrics may appear better if the depot ships as soon as an item is ready, if this is not coordinated with AMC flight

schedules, then there is no real benefit to the customer, and it makes another pipeline segment time appear longer. Thus, while the metrics for the depot may improve and customer service levels appear to be higher, there is no benefit to DoD or the customer.

This article is hopefully a first step in the process of improving the AMC channel system. In any improvement process for a system that is comprised of multiple segments or functions, an essential first task is to identify those segments where problems seem to exist and where the system appears to be functioning efficiently. While the *quick fix* in the short term may be the outsourcing of transportation, in the long term it may be more efficient to redesign the organic network to better reflect post-Cold War logistics needs, particularly if a major part of the redesign simply requires better coordination between the various segments and entities involved.

Notes

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8. Because FedEx does not deliver on Saturday or Sunday, weekends were not included in transit time calculations. In order to accurately account for total shipment time from the customer's perspective, the appropriate number of days were added to each shipment total delivery time when weekends were involved.
9. A Whisker Plot, also called a box plot, is simply the division of the data into quarters. Each quarter of the data is represented on a graph with an x axis for perspective. The top 25 percent and lower 25 percent are shown with lines; the middle 50 percent is displayed with a box divided at the 50th percentile.
10. A Stem and Leaf Plot is similar to a relative frequency histogram, but contains more information. The stem is the left-most common digit of the data, whereas the leaf is the remainder of the data. Stem and Leaf Plots display actual data in a table format in order from smallest to largest, with all data points with like stems listed in the same row of the table with a line dividing the stems and leaves.
11. A z statistic is a mathematical comparison of the data, with assumptions of normality (a bell-shaped curve), consistent variation of the data within each data group and similar variations between data groups. If the assumptions are met, then the data can be compared. If the data groups are close enough mathematically, then the data are said to not be significantly different. If the data groups are different enough mathematically, then the data are said to be significantly different. Hence, conclusions can be made about data groups and whether or not they are the same or different mathematically, with the alpha level simply being how accurate the test is. An alpha level of 0.01 simply means an accuracy of 99 percent in the solution. Also, two-tailed tests look at how different the data groups are by determining if the data groups are different either by one group being greater than the other or vice versa. A one-tailed test simply looks at one side; for example, if group A is greater than group B, but not if group B is larger than group A, whereas a two-tailed test will look at both possibilities.
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Aircraft Airworthiness Symbols and Mission Capable Codes

Carroll Herring

In the day-to-day business of keeping Air Force aircraft flying safely while still meeting mission requirements, the two key management controls are airworthiness symbols and mission capability codes. Several recent aircraft accidents have increased management concern about the use of these symbols and codes. The Air Force cannot afford any confusion on the part of the mechanic or aircrew about which symbol to use. The maintenance documentation must carefully reflect an aircraft's airworthiness. A single error or omission can be disastrous.

Aircraft Airworthiness Symbols

The key to accurate identification of an aircraft's airworthiness is a thorough understanding of the three status symbols used in maintenance documentation as defined by *Technical Order 00-20-1*. Red symbols are used for immediate attention and instant recognition. The actual symbol is based on technical data, the nature of the discrepancy (what is broken, what needs inspection, etc.) and the judgment of the maintenance crew or aircrew. Symbols consist of a Red X, meaning the aircraft is considered unsafe or unfit for flight; a Red Dash, indicating an unknown condition; and a Red Diagonal, meaning an unsatisfactory but airworthy condition. If a Red X is assigned, the aircraft is not to be flown until the unsatisfactory condition is corrected and the symbol is cleared. Special authorization procedures are used to downgrade an aircraft for a one-time flight under tightly controlled conditions with specific restrictions for normal flight operation. Not just anyone can *clear* a Red X—an individual must be on a special certification roster to be granted this authority. Normally, a mechanic must be certified to a 7 skill-level or higher to be on the certification roster. Each major command (MAJCOM) defines specific certification criteria for its mechanics. Next to the Red X, the most serious symbol is the Red Dash. The Red Dash indicates a more serious condition *may* exist. Conditions can include the need for required inspections, accessory replacements, operational check, functional check or necessary maintenance. The third and least

(Continued on top of page 40)

Logistics for the Joint Strike Fighter—It Ain't Business as Usual

Gary Smith
J. B. Schroeder
Barbara L. Masquelier

Introduction

The Joint Strike Fighter (JSF) program is the focal point for defining the next generation of strike aircraft for the Air Force, Navy, Marines and US allies. The focus of the program is performance, balanced with affordability—reducing the costs of development, production and ownership of the JSF family of aircraft. In addition to affordability, three other pillars have been established for the JSF program: survivability, lethality and supportability/deployabiltiy. These four pillars provide the foundation for the design and development of the JSF weapon system.

One of the keys to providing an affordable approach to supportability and deployability lies in the strategy of *Prognostics and Health Management* (PHM) and how it supports the concept of *Autonomic Logistics (AL)*. The foundation for this approach was developed during the JSF Concept Exploration phase with the *Advanced Integrated Diagnostics*[1] (AID) study. The study effort reviewed current aircraft systems and available technologies for promising techniques in prognostics, diagnostics, sensors, diagnostic design tools, maintenance systems and software systems. The product of the AID study was a technology insertion and investment plan that can provide broad reliability and maintainability benefits for major strike weapon systems through the use of advanced diagnostics. With increasing computing and sensing capabilities, moving from a reactive, diagnostic environment to an anticipatory, prognostic system health management paradigm is now feasible.

The Advanced Strike Integrated Diagnostics[2] (ASID) program followed in the JSF Concept Development phase. It provided a definition, design and simulation of an advanced diagnostics architecture. As part of the ASID program, a collaborative Integrated Program Team, led by the Air Force, was established to participate in formulating the architecture. The team included experts from the Navy, TRW, the University of Dayton Research Institute, Lockheed Martin, McDonnell Douglas, Boeing, Northrop Grumman, General Electric and Pratt & Whitney. The developed architecture has the potential to improve reliability and maintainability (over that seen in current systems) by applying diagnostic technologies that achieve 100 percent fault coverage. As envisioned, this would be done through a mixture of on-board and off-board techniques.[3,4] The architecture addressed cost, schedule, benefits and resources that would be required in subsequent phases of the program as well as estimated life cycle cost savings. Architecture features—such as the diagnostic design process, benefits of integrated information flow and feedback between operations, support and design functions—were found to be important attributes. The products of the ASID program were the computer simulation verifying the architecture concept and a road map of technologies and products that need to be exploited in the JSF Concept Demonstration phase.

The AID and ASID programs laid the foundation to support the concept called Autonomic Logistics, an integrated, automated architecture for total vehicle support. This article focuses on the contribution of Prognostics and Health Management, the Joint Distributed Information System (JDIS) and the JDIS relationship to an AL system.[5,6]

Approach

The JSF autonomic support concept is more than the typical number of people, equipment, spares, bombs, bullets and life-support considerations included in a military support system. It is analogous to the autonomic nervous system that directs the body to *breath in and breath out* without being told to do so. The autonomic logistics infrastructure responds with minimal human interaction—making decisions at each step of the sortie generation and maintenance cycle. For the autonomic logistics support concept to work, there must be a stimulus to trigger the system. The Prognostics and Health Management system being developed for the JSF Air Vehicle is the main stimulus that triggers a spontaneous response that sets the AL system in motion.

One of the unique features of the JSF is the timing of the stimulus provided to the AL system. In present systems, the aircraft is *debriefed* only after return from the mission. After landing, the parts, tools and equipment needed to ready the aircraft for the next mission must be ordered, acquired and positioned in order to perform maintenance and service. A Passive Aircraft Status System (PASS) under development for the JSF Air Vehicle will make it possible to simulate the AL system prior to an aircraft's return from a mission. As a result, tools, equipment and personnel can be prepared to perform maintenance before the aircraft lands. Also, in present systems, the human must rely on multiple, diverse sources of information from the aircraft, the pilot and a debriefing system that may or may not focus on the fault in making decisions on corrective actions. PASS relies on an integrated report from the on-board prognostic and diagnostic system that minimizes incorrect maintenance actions and decreases support response requirements.

Getting an aircraft ready to service prior to landing has several other advantages as well. For example, the on-board diagnostic system may report a fault or a fault indication the technician is not familiar with. The AL system provides the capability for maintenance rehearsal prior to actually

performing the maintenance event. While the maintenance technician is working through the event rehearsal, spare parts are ordered. As a result, the technician is armed with both the necessary parts and the experience to perform the fault isolation and repair the malfunctioning system before the aircraft arrives. This allows the aircraft to be returned to *fully mission capable* status far more quickly than is possible with current systems, thus improving sortie generation.

Environment

In today's environment, all US military campaigns are, by definition, joint and require coordinated efforts during operations. However, the logistics support systems for each of the Services contain unique solutions to their individual logistics needs that are not coordinated. Each Service independently determines the support materiel, and the quantities, must be moved into a theater of operations both before and during actual operations. This method of forward stocking of materiel, while effective, is inefficient, contains redundancies and can introduce unnecessary time lags. It can also restrict operational choices and limit when operations begin.

The current logistics support system is reactive versus proactive. This type of system does not anticipate imminent demands for support materiel, personnel or training. It knows what happened yesterday, but it is inadequate in anticipating tomorrow's demands. Because of this, additional parts, support equipment and personnel are required to achieve an acceptable mission capability rate and reduce the risk of in-flight failure. It is also a system that has traditionally relied on *brute force* logistics techniques for supporting campaigns or operations. The use of brute force logistics techniques requires a larger than necessary amount of spares be taken into a theater of operations, additional support equipment and personnel and progressively delivering support materiel while an operation is ongoing. This type of logistics system is not able to think or act on its own. It is also very labor intensive in making decisions and ordering support materiel, cannot translate operational and maintenance data into a decision or action and requires intense human interaction to make decisions at every level of indenture.

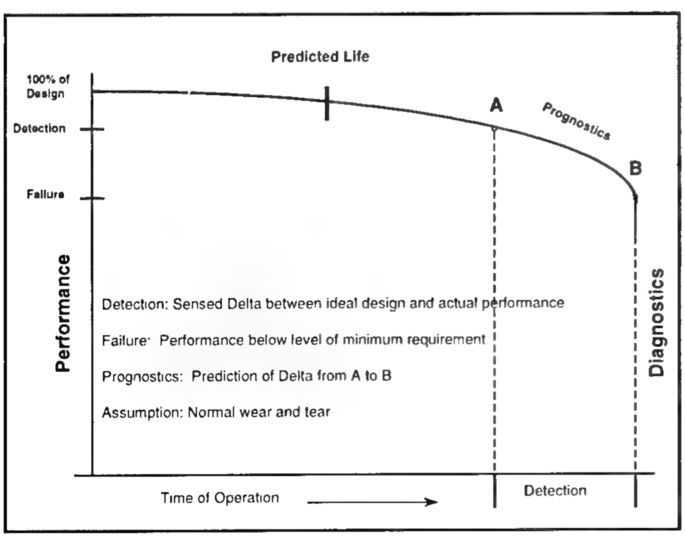

Figure 1. Prognostics Definition

Goals of an Autonomic Logistics System

What are the system characteristics that will enable an autonomic support system? An AL system must be designed with a PHM concept as part of the system engineering process—keeping in perspective the level of reliability, diagnostics and maintainability the system will need and can afford, as well as how the solution fits into the overall support concept. The vision for PHM in the environment of autonomic logistics relies on the connected nature of the system architecture. PHM, the capability of anticipating when a failure will occur, is important in preventing critical failures in flight and allowing the AL system to schedule projected maintenance tasks. This will require the propulsion system, for example, to be equipped with a prognostic capability that will enable the aircraft to leave the end of the carrier deck with the assurance that the mission will be successfully completed. The health management aspect of the system attends to every fault detected. PHM and AL ensure quick return to service of the vehicle, comprehensive data flow to stakeholders in maintenance, operations and logistics and data storage for subsequent analysis. Prognostic data acquired from in-flight and ground support elements of the system will be available for use in diagnosing and performing fault analyses at all levels of maintenance. This will require the various elements of the AL system (both on-board and off-board) to interoperate. Interoperability can only be affordably achieved by designing the AL system in a top-down fashion from the onset of the design cycle and in full coordination with all other aspects of the engineering design process.

Prognostics and Health Management

To help in defining system needs and the parameters that will give an early indication of an imminent failure, the chart in Figure 1 has been functioning as a working definition of prognostics. In any system, there will come a time when performance will begin to degrade. It is the objective of prognostics to sense changes in the system, predict how long the system can function and still give acceptable mission performance and provide operators and maintainers with the projected lead time to schedule appropriate maintenance. This capability will be crucial in the JSF environment where brute force redundancy will be replaced by reliability and prognostics.

Since the system design process is geared to the elements that are common in the world of fault detection and fault isolation, the tools useful for failure analysis will be the starting point for developing a prognostic capability. The same holds true for managing the health of the vehicle and the methodology for cradle-to-grave support. Reverting to the basics of system engineering, the tools for analysis and trade studies need to be applied to sensing, testing, communicating and archiving results to arrive at the final weapon system supportability design.

Coverage and Integration

In order to achieve desired JSF support system goals, the PHM system design process, mature prognostic/diagnostic technologies and defined interactions with the existing infrastructure must be in place. Figure 2 shows that all of the pieces of weapon system supportability must fit together to yield a cohesive weapon system prognostic/diagnostic and

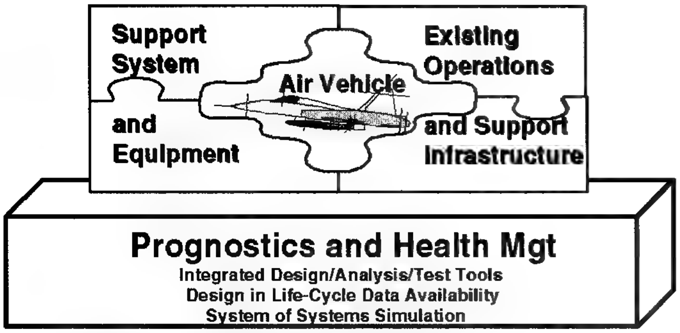

Figure 2. Weapon System Supportability

autonomic support system. Integrated design provides the solution for fitting the puzzle pieces together.

System simulation and analysis will provide the means to a design of the PHM system that will enable the JSF AL system. It is the mechanism to get end users involved early in the design phase in order to ensure the *as designed* PHM and logistics systems meet the needs of the warfighters, enable efficient *what if* analyses to properly determine requirements flow-down/allocation and enable efficient bottom-up design verification.

Feedback

Information availability will be essential to meeting all of the JSF program goals. Performance improvement goals can only be met when feedback is available to the responsible elements and changes made. All of the elements of total life-cycle support currently exist in varying states of maturity and integration. Table 1 illustrates the state of diagnostic/prognostic technology, the direction it is moving in and a notional goal for the JSF. The ultimate goal is to be able to react to actual events with real-time product and process improvements.

Elements	Existing Methods	Developing Methods	JSF Objectives
Fault Prediction (Prognostics)	Fixed estimate of life based on statistical projections.	Improved health monitoring and algorithm development.	Real-time estimate of remaining life assessment by tail number.
Fault Detection	On-board Built-In-Test plus performance evaluation.	Additional Built-In-Test and data capture, for example, F-22/V-22.	Intelligent System Detection.
Fault Isolation	Generally post flight with some fault tolerant redundancy. Remote Engineering Function.	Electronic Technical Orders aid traditional fault tree isolation.	Reasoner Based.
Fault Analysis	Paper instructions and ground support equipment. Remote Engineering Function.	Same	Reasoner Based.
Fault Correction	Engineering Change Proposal process.	Same	Real-time process using knowledge-based Infrastructure.

Table 1. State of Existing Technology

Joint Distributed Information System

The JDIS concept is the heart of the JSF information system (Figures 3 and 4). It is what the JSF logistics and support environment will require to facilitate an information management system that enables autonomic support. In it, the JDIS serves as an *information conduit* that allows for multiorganization, multiservice and multinational information system interoperability. In support of JSF user applications requesting data, JDIS knows *where the data is* and *where to put the data.* As a result, these applications need not keep track of either aspect. As such, JDIS provides *the right information to the right people at the right time.*

Passive Aircraft Status System

The JSF AL program must support an intra-aircraft and air-to-base data link for the transfer of status information. The on-board aircraft status system will track aircraft parameters by analyzing problems, collecting status data and then transferring that data to the ground. Current aircraft have the ability to store aircraft diagnostic information; however, they lack the ability to transfer that data automatically to the ground prior to landing. The existing systems all need human intervention in order retrieve the data from the aircraft.

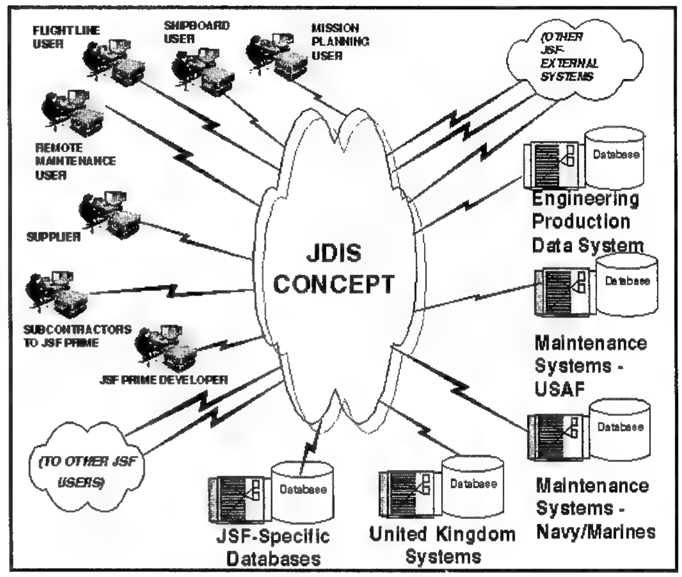

Figure 3. JDIS

The basic structure of PASS gathers the data from systems on the aircraft to a central location and then *bursts* it to a ground station prior to landing. The ground station translates and formats the data for specific applications. That data would most

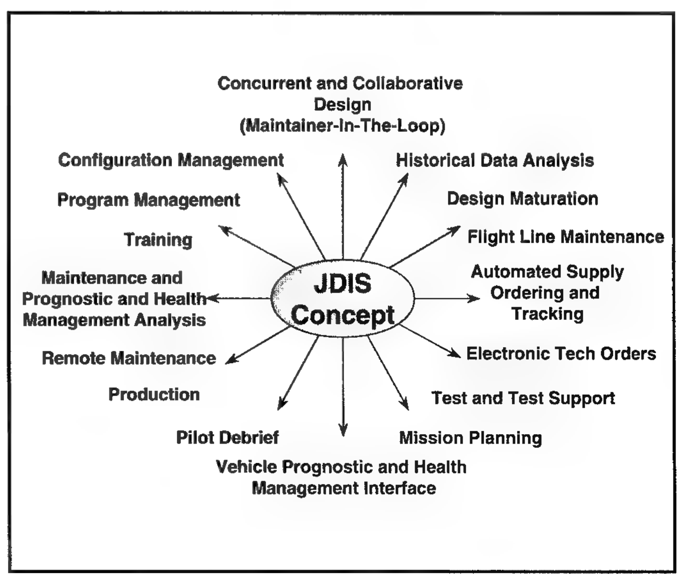

Figure 4. JDIS Application Areas

probably go directly to the JDIS and be distributed to users as needed. Aircraft maintainers and mission planners can use the information to plan the next mission and coordinate vehicle configuration, stores and consumables.

PASS functions transparently without pilot action prior to aircraft landing. After landing, it transmits pilot verification of vehicle performance and documents pilot input. As part of the JDIS, a great deal of aircraft information can also be accessed by the maintainer. This includes software/hardware configurations, historical problems, modifications completed and the status of on-board systems. It is also envisioned that, in conjunction with JDIS and existing data systems, a data-tracking system could be organized and archived for tracking each aircraft. This system would function much like the Internet does today. Each aircraft would have its own *home page* through which a user could access information specific to that particular aircraft. The entire history of that aircraft, as well as an up-to-date accounting system, displaying the configuration of on-board systems, would be available with just a few keystrokes.

A passive aircraft status system is an absolute necessity in order to support the JSF program office's vision for a truly autonomic logistics system. If applied to existing weapon systems, the Air Force and Navy will benefit through better mission capability rates and better warfighter effectiveness. For industry, this system could provide the same time reductions that can support lower operating costs because of less down time at the airport gate or in the maintenance hangar. If planned experiments prove its feasibility, this system could be retrofitted to current vehicles with existing on-board data capture capability, such as the F-22, F-18E/F and the V-22.

Impact on Logistics

AL will change the way systems are tested. The move to a more effective maintenance force, using two-level maintenance and/or contracting with the commercial sector for maintenance services, will require the migration of a prognostic and diagnostic test capability to the aircraft as well as a more effective and affordable means of off-board repair. Test capabilities (for example, Built-In-Test, Portable Maintenance Aids and Automatic Test Equipment) in present systems give an indication when there is a fault but require the technician to do a large portion of the diagnostic analysis and maintenance work to get to the malfunctioning part of the system. For the AL system to work efficiently, a good portion of the diagnostic work must already be accomplished, with the technician at the flight line completing the final work in the maintenance process. To speed up the cycle, PASS must be functioning to decrease the time needed to turn the aircraft around and be prepared for the next mission. JDIS must effectively manage the on-board and off-board maintenance information to provide all technicians and maintenance organizations *real timely* information access. The definition of real timely is *information must be accessible at the time it is needed.* In the case of repair at a remote site or depot, it must be available when the malfunctioning part arrives. For flight-line repair, it must be available prior to aircraft landing.

Support Community

The support community, as a whole, will play a major role in developing the AL system. In past programs, the support systems have always tended to take a backseat to the performance parameters of the aircraft. The JSF program has placed increased emphasis on PHM, its role in supporting the aircraft and the cost implications to the aircraft over its total life. The JSF support system is being designed in a coordinated manner. The on-board and off-board portions of the support systems are being designed and trade-offs made to optimize the support systems' performance. Tools are in place to anticipate and integrate future changes in operations and technology.

Supply and Acquisition

Since there will be a number of customers of some diversity, how are all these customers to be supplied with needed parts and services? The answers may be found in business practices seen in the commercial sector. Presently the Services each have their own supply systems. They also have their own individual aircraft, most of which are Service unique. The JSF, on the other hand, will have a *core of parts* that will be common over a number of variants. These core parts will be supplied by one or more companies and should be available to the Services via their supply system. One of the fundamental tenets of the JSF program, however, is use of the JDIS information conduit, making information transparent to the user. That means, for example, if a technician at an Air Force base orders a part from supply, it could potentially come out of a Navy warehouse.

One of the underlying factors in supply actions is the PHM system interface to acquisition systems and the ordering of parts when PHM is predicting an impending failure. We must ensure that PHM algorithms for predicting failures are accurate, verified and validated and must not task the supply system for resources that are not required. There will have to be firewalls and safeguards designed to ensure the system does not short-circuit and unnecessarily deplete the supply system of parts.

Integrated Diagnostic Virtual Test Bench

We are operating in a market driven by economy and rapidly changing technology. Customers in the commercial market are demanding better and quicker service. There is no reason that customers in the military sector should demand anything less. How do we change the business practices that are presently in place for military customers? How can we tailor the AL system to give it the ability to decrease the military customer lead time and still provide the latest technology in our weapon systems? One of the answers to this question may be the Integrated Diagnostics Virtual Test Bench (IDVTB).[7] The IDVTB is a design/design maturation tool that supports the development of an integrated diagnostic, maintenance, mission planning and logistics system throughout the life cycle of a weapon system. IDVTB will facilitate integration by enabling the balance between existing support infrastructures/equipment and emerging support systems and equipment.

Modeling and Simulation

In the world of autonomic logistics design, a tool set is needed in which multiple discrete events can take place concurrently. The execution of events being controlled by predetermined rules, running under a global architecture,

introduces a complex set of dependencies. Accurate solutions are possible by using simulations that closely mirror the real word in a virtual environment and provide users and managers the ability to visualize the operation of their systems early and often throughout the design cycle. The modeling and simulation functions need to be described and understood clearly before the virtual environment can be designed, simulated and tested against a physical case. The high-level concepts are clear; however, implementation of a multiparadigm simulation is still in its infancy. Additionally, compliance with the Defense Modeling and Simulation Office High-Level Architecture (HLA) may prove to be a formidable problem. Yet such a tool is needed. Industry and government must work together to mature tools in order to develop multiparadigm simulations, virtual reality full motion models, tools for developing models of the full mission and support environment and HLA standards. The IDVTB is the first step in this direction.

Conclusion

Before we field the AL system, a pilot operation needs to be performed to serve as an experiment and to prove the technical feasibility of the system. This will need to encompass the entire spectrum of on-board PHM, off-board repair, information management at all levels and interaction with the supply and acquisition systems. Simulation may be the affordable solution to answering the questions to the problems that we have not as yet discovered. In order to create this type of simulation, there will have to be a value-added partnership created to integrate both government and commercial entities as a set of independent companies that are working closely together to interface and integrate all the parts of the AL system.

Notes

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Integrated Logistics System—Supply

Second Lieutenant Richard E. Mills, Jr.

The Air Force selected the 42d Supply Squadron at Maxwell AFB, Alabama, as the test site for the Integrated Logistics System-Supply (ILS-S). ILS-S replaces the Standard Base Supply System (SBSS), the current legacy system that has been in operation for more than 30 years.

> Our work with the Standard Systems Group and Lockheed Martin developing this next generation supply computer system will ensure supply units throughout the world receive the best system possible to address today's and future demands,

said Staff Sergeant Mike Brown, 42d Supply Squadron local area network specialist.

ILS-S is a Windows-based program that is easier to operate than the SBSS, according to Major William Predeau, 42d Supply Squadron Management and Systems Flight Chief. It provides the supply organization with total asset visibility for all property in storage, in transit and at other bases throughout the Air Force.

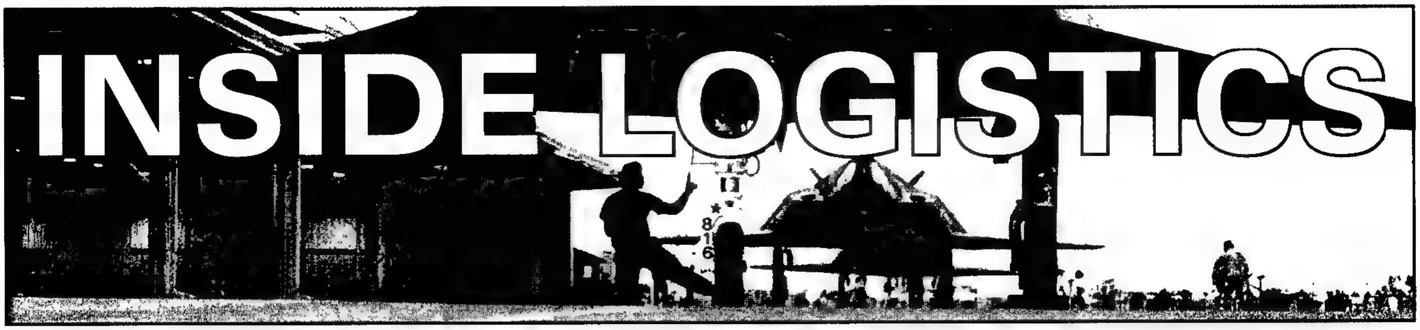
"It will decrease time, money and manpower needed to support base supply customers," said Predeau. Many tasks accomplished in today's SBSS system require several screens to complete. ILS-S will take these same tasks and accomplish them from one input screen.

The new ILS-S allows supply personnel to meet changing Air Force needs because it can be expanded as demands and technology change. Updating information in ILS-S will be easier and less time consuming than with the SBSS.

ILS-S will have the capability to allow the customer to place an order from a desktop computer, thus eliminating the current requirement to call supply's customer service. Although this capability is several years away, when it becomes available, it will create a seamless integration with all supply customers, eliminate the middleman—in this case, supply—and free supply personnel for other tasks.

One hundred fifty personnel, inside and outside of the supply complex, will be trained in the use of the new system. "Our in-house training team has created an in-depth program to ensure our personnel are fully qualified on all aspects of the ILS-S and are prepared to assist with the worldwide implementation," said Staff Sergeant Hayden Pickett, 42d supply clerk. Trainees get experience processing transactions in the new system and are given the opportunity to provide comments on system efficiency and recommend changes to the Standard Systems Group. Picket said:

> ILS-S enhanced capabilities using the Windows-based environment is an overdue upgrade to our current legacy system, SBSS. In the 42d Supply Squadron, we are excited to have the opportunity to help test the logistics system that will take the Air Force into the next millennium.



EXPLORING THE HEART OF LOGISTICS

For Want of a Spanner

Robin Higham, PhD

A curious minor logistical mystery of Royal Air Force (RAF) history in World War II was and is the shortage of hand tools. This lasted well into 1943, 4 years after the war began and 9 years after rearmament started in 1934.

Before wartime expansion, fitters and riggers did their initial course at No. 1 Technical Training School at Habton. They specialized as engine fitters or as airframe riggers. Upon completion of the course, they were sent to squadrons where in 7 years their education was completed.

At the squadron, they reported to A, B or C Flight where they were issued a tool kit. If they were transferred from one flight to another, they had to turn in their tool kit and have the contents accounted for before proceeding across the street to draw another set from their new flight. In biplane days, a fitter or a rigger assigned to a two-seater not only acted as the gunner, but also in colonial theaters, lashed his toolbox to the wing next to the fuselage in case of a forced landing.

What makes the case of the missing hand tools so intriguing is that the historical documentation concerning the ordering of such necessary items has disappeared (meaning it has either been destroyed or it has been filed with the papers of a successor organization of unlikely title).[1]

The first clue to the problem came from the operational record book (ORB) of a repair and salvage unit (RSU) in the Middle East in 1940, which opened by noting that of the RSU's 62 personnel only 25 had tools. So they were happy to pass on salvaged aircraft to whoever claimed them.

What this meant was, in a theater then desperate for serviceable aircraft, many were standing idle because the necessary repairs could not be made *for want of a spanner*, let alone the necessary spares.

The matter is important because as late as 1943 in Burma (Southeast Asia Command or SEAC), the Beaufighters of No. 26 Squadron only sortied once every 18 days due to lack of tools and spares.

The fact that the RAF had insisted on standardized nuts, bolts and other fittings meant that special tools were not needed. Unserviceability was due to the unavailability of regular tools.

Notes

1. Apart from the fact that we cannot locate the papers of the gentlemen in the Air Ministry who were responsible for ordering tools from specific companies, we have to face a loss of the equipment (engineering) officers' ORBs or monthly reports. It seems that the junior officer in a squadron was, at least until Maintenance Command was formed in 1938, the engineering officer. This essentially meant that he went down to the tarmac or the hangar in the morning and signed off on the form the flight sergeant gave him. There was, apparently, an engineering section of the ORB, and certainly at the end of World War I in 1918, there was a monthly engineering officer's report attached to the ORBs.

   What happened later on seems to have been that when the records were pruned in the Air Ministry Archives before being sent to the Public Record Office. It was assumed that such mundane information was unimportant.

   But it is also possible that we may find the engineering part of squadron ORB's. A recent suggestion is that those reports may have been filed with those of the new station engineering or equipment officers.

Dr. Robin Higham is currently Professor Emeritus of History at Kansas State University.

Contemporary Logistics Techniques for Allied Supply Support

Craig Brandt, PhD

Introduction

Changes in the political-military environment and a revolution in the way that commercial logistics is being conducted are paving the way for new logistics standards in the military. In the US, there is a surge of interest in using the best of these commercial practices, and accompanying this is a move toward privatizing many noncombat logistical functions. While other nations may be undergoing such changes in their thinking, there has been little effort to look at our current system of foreign military sales (FMS) support. However, by adapting these new techniques, it is possible for the US and its allies to improve their mutual logistics support.

The Military Environment

The end of the Cold War forced a new look at the military and how it should be employed under the current circumstances

throughout the world. The focus on regional rather than global warfare is changing the shape of the logistics system. Instead of huge battles of division-sized forces employed across an easily determinable front, which would allow prepositioned supplies and equipment, new military doctrine emphasizes flexible response from combatant units deploying around the world with a small logistics footprint. Instead of each Service preserving its own niche in warfare, jointness stresses the ability of the Services to work together in an effort to capitalize on the strengths of each without duplication of resources that detract from an optimum combat capability. As the Gulf war proved, a major regional conflict is apt to rely on closely coordinated military efforts of a multinational coalition, indicating that the ability of countries to work together is extremely important in determining a military outcome. While our FMS system has always been at the forefront of interoperable forces, this new prominence devoted to alliance behavior, coupled with advances in logistics, can further enhance the possibilities of coalitions.

The Logistics Environment

In the last few years, the emphasis on customer service has led to the reexamination of logistics systems in both the private and military sectors. National deregulation of transportation has spawned innovative schemes that have driven down the price of transportation while dramatically shortening delivery times. With the improvements in transportation, faster cycle times can be achieved and lower inventory costs obtained as transportation is traded for stocks of inventory. As firms commit to concentrate on core capabilities, there has been a growth of third-party suppliers, especially firms who can take over the entire logistics function—including inventory management, transportation, warehousing, packaging and requisition processing. World interest in free trade has increased dealings abroad. Globalization means, more than ever before, that companies are able to engage in international commerce, which has been made easier by regional economic agreements, simplification of customs regulations and electronic data interchange. Logistics changes prevalent in the private sector are also being realized within the military.

FMS Supply Support Today

If we look at today's system for supply support under FMS, we find that an ally's requirement must first pass through its own national system before being transmitted to the United States. Although there are as many systems as FMS purchasers, a typical route would be for the requirement to pass from a flight-line customer to the servicing supply center, then to some centralized supply center and, frequently, to another centralized agency, often at the ministerial level, which controls requisitions submitted under FMS. The US has no control over this system. In fact, the United States historically has had little interest in it. Its view of the completion process has been the delivery to the purchasing country's freight forwarder in the US. From the country's point of view, this system has normally emphasized control at the expense of customer service, especially as it relates to the ultimate user of the spare part. In fact, complaints from the lower levels of a purchasing country's organization about lack of American responsiveness are often better aimed at a cumbersome bureaucracy within the country itself that often takes weeks or months to submit the requirement through FMS.

Again, it must be emphasized the US cannot dictate another country's administrative systems. Nonetheless, if both countries truly believe customer service is important, then mutually we can work to improve support to the flight line. The technology is available to permit a streamlined flow of information to the US from the ultimate user. The challenge is to modify the administrative procedures already in place.

Currently, all FMS customers submit their requisitions for follow-on support to the Air Force Security Assistance Center (AFSAC) at Wright-Patterson AFB, Ohio. Requisitions are prepared in Military Standard Requisitioning and Issue Procedures (MILSTRIP) format and submitted in a variety of ways. Most commonly today, FMS customers are employing the International Logistics Communication System for sending requisitions and receiving status. This is a modern computer-to-computer technique that enters the requisition into the Security Assistance Management Information System (SAMIS), the management system employed by AFSAC, and ultimately to the USAF requisition processing system. Coupled with some front-end processors called Supply Tracking and Reparable Return/PC, FMS requisitioning is a fast, reliable method of getting requirements into the USAF supply system and an appropriate use of electronic data interchange.

After passing through SAMIS, in which the requisition is checked for MILSTRIP compatibility and adherence to FMS requirements and funds availability, the requisition is then passed to the inventory manager at the source of supply, either within the Air Force or at the Defense Logistics Agency (DLA) or another Service manager. Here the item manager checks to see if the requisition complies with the general FMS rules for issuing the material. If the requisition is approved, the materiel is issued from the appropriate DLA depot. The item is shipped by a logical means to a freight forwarder employed by the foreign purchaser. Normally, this freight forwarder is an American company, located in a tidewater area, that receives materiel and stores it until forwarding it to the purchaser. In some cases, an agency of the purchasing government may serve as the freight forwarder.

The actual movement of materiel is technically the responsibility of the purchasing country. However, the nature of the materiel—that is, often small packages originating from military depots around the country or directly from a multitude of vendors—traditionally has meant that the US will choose the means of transportation and charge the customer accordingly. Normally, small package shipments sent by mail or small package carriers are charged through the FMS billing system at a rate of 3.5 percent of the item value. If the item is large enough or if enough items from a single source can be consolidated into a large enough package, they are shipped on a collect commercial bill of lading. In this instance, the purchaser, often by means of the freight forwarder, pays the freight charges in the commercial sector without referral to the FMS billing system. In accordance with FMS rules, title to materiel normally passes to the customer at origin, thus relieving the US of further responsibility for the shipment as soon as it leaves the depot or the vendor.

Further shipment to the purchaser country is arranged by the freight forwarder. Depending on the emphasis placed on logistics responsiveness by the purchaser, the freight

forwarder might provide different transportation arrangements based on requisition priority or alternatively look for a low-cost transportation solution. When the materiel is received in-country, it is processed and transshipped in accordance with national procedures. Again, this segment of the logistics pipeline is generally unknown in the US and irrelevant to most in the FMS process.

Transportation Improvements

A first step toward streamlining the current interlocking systems might be easiest accomplished by focusing on the transportation segment. Innovation in the transportation industry has realigned roles that might be beneficial in creating a more responsive supply support system. Carriers themselves might now arrange shipments directly from the depot to the purchasing country, bypassing the need for a freight forwarder that acts only to collect materiel and arrange for onward transportation. Alliances between American and foreign carriers could provide a single company to handle the transportation from origin to destination. By contracting with a single carrier, all freight intended for a single country could be handled by the same firm, rather than using the next available carrier under the normal US system. Such a contract could yield savings in transportation costs over the usual less-than-truckload rates, which would normally prevail. If the carrier can assume responsibility for the entire route, abroad as well as in the Continental United States, a separate contract for a freight forwarder will also be avoided. With the tracking systems frequently employed by major carriers, tracking of shipments would also improve.

As the cost for international small package express shipments decreases, a country might investigate negotiating with such a carrier for high-priority shipments. Again, carriers today can deliver from overseas locations directly to a US location. This mode might yield faster response times and greater control. In addition, depending on freight rates that might be negotiated, this method might also be suitable for handling reparables. In this manner, the transportation segment of the logistics pipeline will be cut to its minimum, reducing holding costs for high-value inventory.

Next: Privatized Supply Support

While transportation advances could be adapted by foreign purchasers without any other change in the supply support system, there are still other modifications that could be made. This proposal suggests privatization of the role of AFSAC in providing follow-on supply support, relying instead on a third-party purchasing agent under contract to the purchasing country. This would eliminate any US Government involvement in the supply support system.

Currently AFSAC is an intermediary in the providing of spare parts, receiving requisitions, confirming availability of funds and passing the requisition to a source of supply. AFSAC maintains no stock and is not involved in the procurement of materiel or its shipment to the purchaser. At the air logistics centers (ALCs), foreign requisitions are filled in the same manner as USAF requisitions, although generally foreign requisitions are of lower Uniform Materiel Movement and Issue Priority System priority and thus are apt to be put at the bottom of the in-basket. Materiel availability from Air Force stocks is a function of generalized rules that revolve around whether or not a country has *invested* in the American system through a Cooperative Logistics Supply Support Arrangement. Although materiel may be in stock, it may be unavailable to satisfy a foreign requirement. The requisition and financial tracking systems are convoluted and require heavy manual intervention.

Current Privatization Initiatives

In the case of materiel not readily available—that is, materiel considered *nonstandard*—even the Air Force has decided to employ a third-party purchasing agent. In 1990, as a means to improve response times on items not stocked by the ALCs, the Nonstandard Item Parts and Repair Support (NIPARS) system was created. AFSAC contracted with a team of companies to relieve the ALC of locating a source and purchasing difficult items. This meant requisitions would still flow through FMS channels, but eventually a decision would be made to refer the requisition to the NIPARS contractor rather than to the normal source of supply. The contractor's fees were included in the price ultimately charged the customer. The FMS administrative fee of 5 percent was still paid to cover US Government involvement in the process. This system was quite successful in cutting lead times for items compared with earlier procurements by the ALCs.

Because of the success of NIPARS, it was expanded in 1995 to the Parts and Repair Ordering System (PROS). A program of greatly expanded scope, it includes support, not just for nonstandard items but for all spares, including reparables. The concept acknowledges the value in a profit-driven, third-party supplier, but it still operates within the confines of the FMS system. Materiel status has to be provided to AFSAC so it can be incorporated into the MILSTRIP system before being passed to the customer. FMS financial systems, already unbelievably cumbersome, must be modified even further to accept billings from the PROS contractor. As a US Government contract, the management and administration of the contract still require adherence to federal acquisition regulations. Ultimately, while relieving the difficulties at the ALCs, a new bureaucracy at Wright-Patterson AFB has been created to cope with the contract administration. And of course, the foreign customer stills pays for this government overhead.

Benefits of Total Privatization

Since it seems obvious that the private third-party can successfully handle the most difficult cases of supply support where no materiel or repair capability exists, then transferring responsibility for all supply support to a private contractor can easily be accomplished . In fact, this has been admitted by the Air Force under the terms of the new PROS contract. What is not obvious is the value of maintaining such a contractor under the auspices of AFSAC.

If a foreign country were to contract for a third-party purchasing agent, even using a contract similar to that employed in PROS, there would still be benefits for the purchaser. Now there would be a direct link created from the foreign country to an agent under its control, not under the control of the US Government. No longer would the cumbersome information systems of SAMIS, MILSTRIP and finance drive the information requirements. A country could agree with a contractor on a requisitioning system that would employ outputs from its own logistics systems rather than converting everything into a format acceptable to the Air

Force. Since the first stop of the requisition would be the contractor, rather than a variety of intermediaries who must first decide whether they want to act on it, response time will be improved. Past experience has shown that contractor responsiveness to requests for difficult items has greatly improved over government buyers. It is unlikely that such disparity will exist for standard parts, yet as US stocks get lower and there is more reliance on vendor-managed inventories, it is likely that a contractor can still better the government's delivery times.

Financial reporting will be much simplified. Today's FMS financial system requires that all charges be transmitted as charges against a line-item requisition, which often requires substantial manipulation of cost data. In addition, transportation charges, where applicable, are based on a percentage of purchase price rather than on actual movement cost. As businesses of all stripes become more adept at international commerce, international financial transactions should become commonplace and present little difficulty to the purchaser or contractor. In all likelihood, a private contractor should be able to develop a financial system that will not require the heavy advance payment of the FMS system.

A contractor representing a single foreign purchase could develop a strategic alliance with a transportation company, something that the PROS contractor representing the US Government cannot. Thus, the possibility of revolutionizing the transportation segment of the follow-on support cycle is more likely to occur with a private third party than under participation in FMS.

The bottom line of moving toward a private third-party purchasing agent, then, is faster cycle time for the foreign customer. Air Force attempts such as NIPARS and PROS, as well as the Navy's analogous program Fast Line, have shown the value of privatization. It is time to take the next step and remove the final government intermediaries in the support process and turn the entire system over to a relationship between a country and its agent, where the purchaser is free to construct an arrangement that suits it but is not dependent on the intercession of the Air Force.

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Dr. Brandt is currently the Director of Foreign Military Sales at the Defense Information Systems Agency. At the time of writing this article, he was a Department Head for the Graduate School of Logistics and Acquisitions Management at the Air Force Institute of Technology.

Best Article Written by a Junior Officer

The Executive Board of the Society of Logistics Engineers (SOLE) Chapter, Montgomery, Alabama, selected "Deploying and Sustaining an F-117A Expeditionary Fighter Squadron: Why Agile Combat Is Needed Now" (Volume XXII, Number 4), Captain Jamie D. Allen, USAF, and First Lieutenant M. Brian Bedesem, USAF, as the best *Air Force Journal of Logistics* article written by a junior officer for Fiscal Year 1998.

Logistics Lessons Learned Award

The Air Force Historical Foundation selected "The Political Economy of Privatization for the American Military," (Volume XXII, Number 2), written by Colonel R. Philip Deavel as the best *Air Force Journal of Logistics* article that contains logistics lessons learned for Fiscal Year 1998.

Most Significant Article Award

The Editorial Advisory Board selected "Mergers and Acquisitions in the defense Industrial Base—Should the US Military Be Concerned?" written by Lieutenant Colonel Kevin A. Bell, USAF, as the most significant article in Volume XXII, Number 4 of the *Air Force Journal of Logistics*.

Space-Based Infrared System—Supportability Engineering and Acquisition Reform in an Existing Acquisition Environment

Richard J. Fickes
Kenneth A. Good, PhD

The Space-Based Infrared System (SBIRS) is a consolidated, cost-effective, flexible system designed to meet US infrared global surveillance needs through the next several decades. It uses a streamlined acquisition approach to develop and field an integrated *system of systems* including multiple space constellations and an evolving reparable and redundant ground segment. SBIRS is being developed in three increments. Figure 1 depicts the final SBIRS

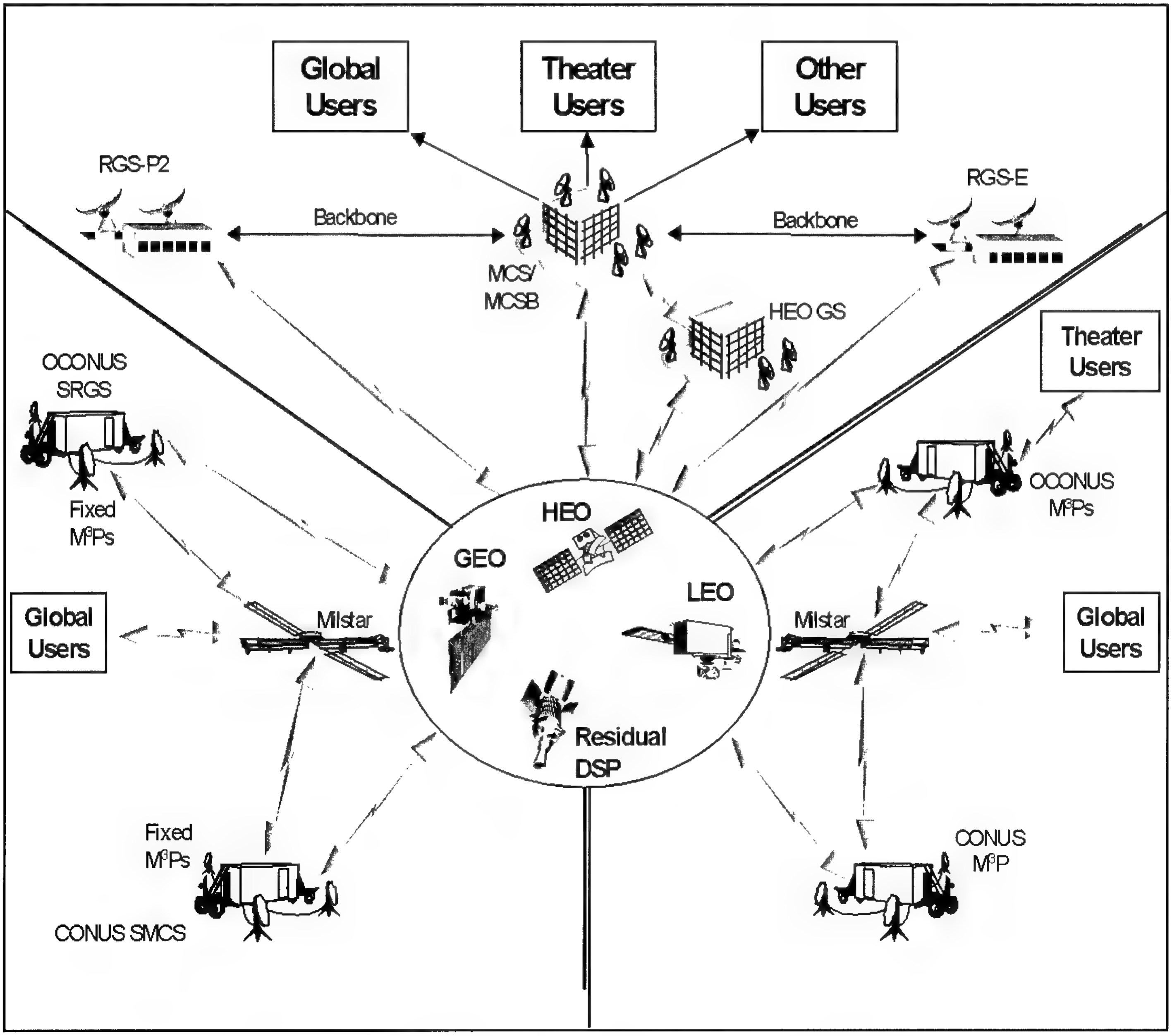

Figure 1. SBIRS Architecture

architecture consisting of a Space Segment with Geosynchronous Earth Orbit, Highly Elliptical Orbit, Low Earth Orbit and residual Defense Support Program satellites and sensors. The Ground Segment consists of *peacetime* elements, theater/endurable elements and survivable elements. The primary Ground Segment assets include the Mission Control Station, Relay Ground Stations, and Mobile Multi-Mission Processors with backups. SBIRS is the *flagship* program of Air Force acquisition reform for procuring a large, complex space system.

This article discusses supportability requirements definition and the implementation of supportability engineering in SBIRS evolution from an Integrated Product Team (IPT) aspect. The discussion includes experience and lessons learned from the logistics infrastructure acquisition during the Engineering, Manufacturing and Development (EMD) phase. SBIRS supportability acquisition is occurring under the umbrella of the Department of Defense *new acquisition reform*, IPTs and Total System Performance Responsibility (TSPR). IPTs are the key management, issue resolution and interaction avenues between the user (Air Force Space Command [AFSPC]), the System Program Office (SPO) (Space and Missile Center [SMC]) and the contractor (Lockheed Martin). This article details the actual roles and responsibilities of the user, program office and contractor with the intent to demonstrate how supportability engineering in an existing acquisition reform environment really functions. SBIRS is the first program to be acquired under this trinity of government initiatives. It is, therefore, in a pathfinding mode with respect to discovering what these initiatives really mean on a day-to-day basis and how they affect the working relationships among the SBIRS community—SMC; AFSPC; government System Engineering and Technical Assistance (SETA) contractors and the SBIRS Ground Segment contractor, Lockheed Martin.

As the user representative, AFSPC is responsible for operational and supportability requirements development, definition and clarification. Specific performance-based supportability requirements are defined and documented in the SBIRS Operational Requirements Document. With the program now in the EMD phase, AFSPC maintains a disciplined requirements review process, as depicted in Figure 2, to accept and evaluate potential new SBIRS requirements from the user community. Potential requirements changes are rigorously evaluated by the user working groups, AFSPC, SPO and Lockheed Martin before possible acceptance. The basic goal of this disciplined requirements process is to preclude the *requirements creep* experienced by past acquisition programs.

Current SBIRS supportability requirements are developed in accordance with Air Force acquisition reform tenets. No military standards or specifications are used to define supportability engineering requirements or state compliance. All documented supportability engineering requirements are *performance-based* statements reflecting a need rather than a solution. Reaction from the user requirements community concerning the new paradigm of performance-based requirements was decidedly mixed, ranging from one extreme to the other. One response, particularly from the operational community, was that the supportability engineering requirements were too long. One page *we need supportability*

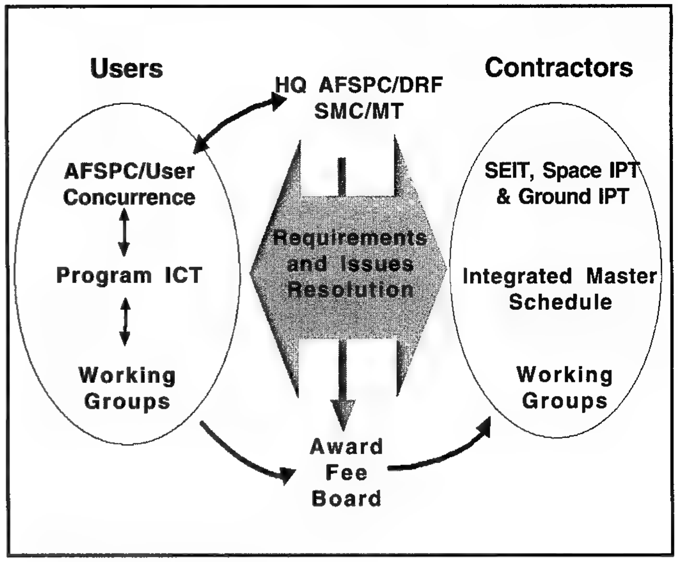

Figure 2. Requirements Review Process

was deemed sufficient. The other extreme, primarily from the *old* supportability community, was that the new requirements were not sufficiently detailed. That community consistently wanted to state requirements as solutions rather than needs. The final version of supportability engineering requirements documented in the SBIRS ORD are a complete, balanced and performance-based set of stated AFSPC needs that do not stipulate solutions. The SBIRS contractor is allowed the flexibility to develop innovative contractor solutions to AFSPC needs without the limitations of military standards, military specifications or military processes. The AFSPC Directorate of Requirements for Force Enhancement-Sensors (DRFS) evaluates and monitors the contractor's proposed solutions to ensure the stated SBIRS needs are met.

Another major paradigm shift in the definition of operational requirements and metrics is the SBIRS Operational Dependability (D_o) parameter. D_o, rather than the more commonly used Operational Availability (A_o), is the key driving supportability factor for SBIRS and is considered an element of system performance. A_o is a function of nonmission time, however, SBIRS is a 24-hour a day, 7-day a week, 365-day a year operating system. There is no nonmission time. D_o is a function of mission time and quantifies the probability that once the system is turned on it will remain on and reliably perform its stated mission.

AFSPC/DRFS created Integrated Concept Teams (ICTs) to bring together the SBIRS user and operator communities to discuss and monitor major SBIRS issues, including supportability engineering. Three ICTs (Space, Ground and Program) exist as the forum for discussion and issue resolution. These three ICTs correspond to and interact with the Space and Ground IPTs and the System Engineering and Integration Team. During the EMD Phase, AFSPC participates in the ICTs and IPTs, provides requirements clarification to the SPO and Lockheed Martin and evaluates contractor performance through the award fee process. At the AFSPC level, an Integrated Logistics Support (ILS) Working Group is a subset of the Ground ICT to specifically work and monitor supportability engineering issues for AFSPC. At the contractor level, an ILS IPT is a subset of the Ground IPT. Representatives from each team serve on both the ICT and

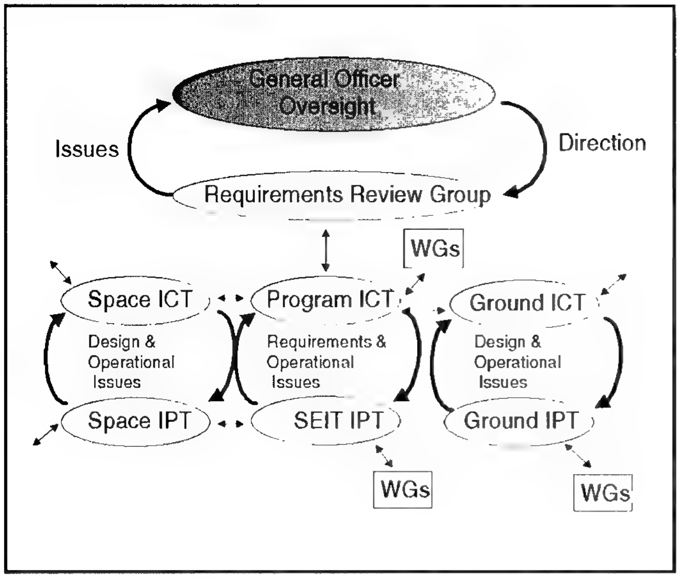

Figure 3. Team Interactions

IPT to ensure interaction and coordination. The interaction of the various teams is depicted in Figure 3.

The SPO manages the program to procure SBIRS according to the agreed-upon schedule and delivery dates and within budget and staffing resources allocated to the program. The SPO performs contract monitoring, participates in all ICTs and IPTs and administers the award fee process. The award fee is a critical element of the acquisition process. It is designed to provide incentives for innovative contractor management and engineering. SMC/MTL is the office specifically responsible for ensuring that all supportability requirements are integrated as system performance parameters and accomplished IAW the agreed-upon schedule and levels of performance quality.

The 9 February 1996 Secretary of Defense acquisition reform mandate directed maximum program streamlining and encouraged the maximum use of existing commercial equipment, infrastructure and processes to save acquisition time and resources. This mandate dovetailed nicely with both the SBIRS acquisition strategy and the long-held contention of major defense contractors that great savings would be possible if they were unburdened by specifications, standards and reprocurement competition. Under the TSPR adopted by SBIRS, the SPO manages the overall SBIRS program and retains responsibility for requirements definition, operational system acceptance and mission assurance to AFSPC. Requirements are generally defined with *performance specifications* rather than the traditional array of government specifications and standards. Lockheed Martin has wide latitude in meeting the prescribed parameters. They assume *total responsibility* for the design, development, integration, test, delivery and sustainment of the new system. Other space oriented systems have employed TSPR-like concepts but only up to the Operational phase. It is the continuation of contractor responsibility for sustainment into the Operational phase, and potentially for the life of the system, that makes this approach unique. TSPR is a dimension beyond traditional contractor logistics support (CLS) since the support system infrastructure remains with the contractor who provides both depot- and organization-level support in a sole-source environment.

The SBIRS program uses performance specifications and nongovernment standards in lieu of military specifications and standards, unless required. Under TSPR, Lockheed Martin is given maximum flexibility to conduct the program efficiently while still providing the government with clear visibility into cost, schedule, technical performance and risk. In turn, Lockheed Martin is responsible and accountable for their performance. As the total system integrator, they assume TSPR as outlined in the performance requirements of the contract. Their responsibilities include: (1) performing system of systems performance analysis and design; (2) providing timely insight into SBIRS program status including ongoing risk assessment and risk management measures for all technical, cost and schedule aspects of the total program and identification of problems, development of alternative solutions and recommendations for implementing proposed solutions. The cornerstone of the SBIRS program is effective control of the life-cycle sustainment cost for the ground segment while meeting system performance requirements. The SPO focuses on managing the SBIRS TSPR program through *insight* under the auspices of streamlined acquisition.

The management philosophy under TSPR is through effective use of ICTs, contractor-led IPTs and the award fee incentive. Since Lockheed Martin is providing a system that will be operated on an Air Force installation, by Air Force personnel and will interface with other Air Force and government systems, participation by technical personnel from the SPO, AFSPC and supporting commands on AFSPC-led ICTs and Lockheed Martin-led IPTs is a major key to success. This environment enhances the relatively unfettered flow of information to both government and Lockheed Martin decision makers. In order to maintain program baseline stability under performance-based contracting, IPTs are used to manage the requirements process while Cost as an Independent Variable (CAIV) and life-cycle cost reductions are the primary focus of the award fee process.

Traditional roles, responsibilities and authority of the program office are transferred to Lockheed Martin. The primary means of communicating Lockheed Martin progress and interfacing with the user is through the IPT. IPTs, in this sense, are not only for status updates but also a forum for bringing up issues; discussing, identifying and developing solutions; and assigning action items to members—unlike the traditional IPT approach where the government typically leads, identifies problems, directs solutions and approves contractor solutions. Under TSPR, action items may be and are regularly assigned to government representatives, and the entire team owns the issues. Various working groups within the IPTs continually balance cost, schedule and technical performance against performance requirements.

The SPO's challenge is to keep requirements growth in check. Requirements are derived from performance specifications as stated in the SBIRS ORD and allocated to Ground Segment and Space Segment specification. In order to manage requirements growth/changes, the program has implemented requirements management processes where the appropriate segment IPTs validate changes to the SEIT, which in turn are validated in the MIPT. The single voice from the user community is HQ AFSPC/DRFS. Ultimately, changes must be *blessed* by AFSPC/DRFS who owns the basic requirements and controls the *checkbook*. Many new requirements and improvements are discussed at the working

level, with most being eliminated at this stage. Ultimately, the Management IPT—composed of Lockheed Martin senior managers, the SPO program manager and HQ AFSPC/DRFS—controls the change process.

The award-fee process is another method to control change by incentivizing the contractor to meet performance requirements in cost and on schedule. The award fee plan awards Lockheed Martin a maximum award fee of 20 percent for each evaluation period. The fee pool is broken out as follows: cost 50 percent of fee pool, technical management 45 percent of fee pool and management 5 percent. The award fee pool emphasizes performance-based contracting with the most emphasis on cost control. Prior to entering each award fee period, Lockheed Martin enters into agreements with the government IPT members to identify expectations and accomplishments within the constraints of the Integrated Master Plan. Their performance is motivated by both positive and negative incentives. Positive incentives include a significant award-fee pool and the opportunity to share in documented life-cycle cost savings. On the negative side, they must meet specific performance criteria and must not breach an established cost ceiling. Failure in either area will cause the government to demand delivery of a reprocurement data package within 12 months and result in loss of sole source sustainment. Although the negative aspects are key to this TSPR strategy, AFSPC retains some trepidation, believing business decisions may take precedent over the judgment of the operational commanders. The key challenges to successfully implementing TSPR sustainment facing government IPT members are:

- Establishing and tracking the operations and maintenance baseline.
- Validating life-cycle cost reductions.
- Documenting ceiling increases.
- Effectively managing the award-fee processes.

As the contractor, Lockheed Martin has TSPR for the entire life cycle of SBIRS. They are responsible for the development, deployment and sustainment of SBIRS. Lockheed Martin has the maximum possible flexibility to define schedule tasks, subject to operational need dates, and remains responsible and accountable for meeting contractual milestones. They are also responsible for the transition of user requirements to contract specifications. Lockheed Martin determines the supportability design parameters that control metrics and affect system design, evaluate supportability options and allocate critical supportability parameters to SBIRS subsystems. They establish the processes to control the supportability design parameters and achieve operational objectives. Lockheed Martin's requirements resolution process provides for response to changes; continuous improvement; analysis, test, and fixes and identification of potential variances and corrective actions. Supportability parameters are documented in the appropriate specifications, controlled through their configuration control process and electronically available to Lockheed Martin personnel, the SPO, and users through the CALS-compliant Sustainment Online Database and Electronic Data and Management System databases. Lockheed Martin participates in all the ICTs and IPTs to resolve issues and provide the government with adequate visibility into schedule and other issues so that the SPO and AFSPC can make independent assessments of program status and schedule risks and understand Lockheed Martin's projections of schedule milestones and other events. Figure 4 shows the organization of the logistics (and specialty engineering) activities within the Integration, Assembly, Test and Checkout team and the relationship of these activities to the other IPTs. Figure 5 displays the manner in which logistics and the related disciplines integrates the new acquisition initiatives and CAIV into both the system design and the support infrastructure.

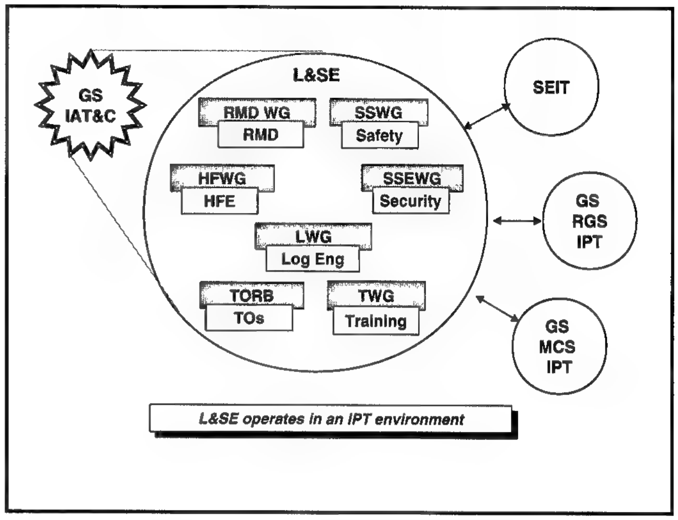

Figure 4. Integration, Assembly, Test and Checkout Logistics and Specialty Engineering Activities

Perhaps the most striking features of the new acquisition initiatives and TSPR for government and contractor logistics engineers reared in the classical DoD acquisition processes are Lockheed Martin's:

- Freedom to determine supportability engineering tools and processes.
- Openness with the government and their SETAs.
- Interaction with the government in two distinct roles.
- Involvement of government personnel in the development of the system.
- Increased level of responsibility for the overall operation and maintenance of the system.

To begin with, it is obvious that, in order to acquire the supportability infrastructure for any system, the same set of supportability functions has to be completed (for example, support and maintenance concepts have to be enunciated, spares lists developed, spares ordered, maintenance procedures written, staffing levels and profiles derived and technical manuals and training courses generated). The trinity of government acquisition initiatives (reform, IPTs and TSPR) does not change this list of functions. However, some of their features allow Lockheed Martin to determine the depth to which each supportability function will be performed for SBIRS.

New acquisition reform has a major impact on supportability engineering because it allows CLS (or as Lockheed Martin calls it, Contractor Sustainment) at the operational sites as well as at the depot and the use of

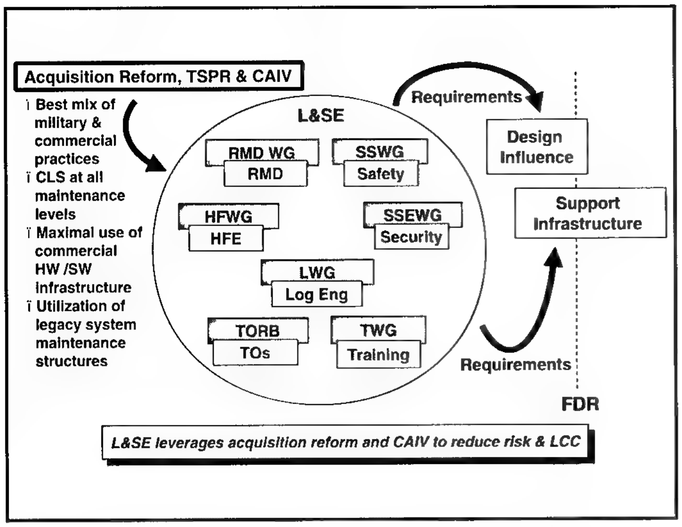

Figure 5. Logistics and Specialty Engineering Approach

commercial-off-the-shelf equipment. In the development of the Logistics Support Analysis (LSA), many of the tables that are traditionally generated to ensure effective service through the government supply support and depot systems are not developed for SBIRS. Although a database tool is utilized as a repository for LSA data, it will not be kept current for the duration of the SBIRS life cycle. The database will be retired shortly before the Increment 1 Initial Operational Capability and kept for reference only. All the usual data required for sustainment of the system will be kept in a database tailored for this purpose from a commercially available database application. In fact, if Lockheed Martin had known at the beginning of the program what they know today, they most probably would have tailored a commercially available spreadsheet for the LSA. Under acquisition reform and TSPR, such enormous freedom is afforded to implement processes that are creative and efficient. This freedom is handled with care to ensure no significant risks are added to SBIRS supportability engineering by enthusiastic implementation of untried and unproved, *good sounding* ideas.

Similarly, IPT changes the supportability engineering landscape. There exists a distinction between IPT *the meeting* and IPT *the process*. The former refers to the monthly or bimonthly status meetings with large attendance from the acquisition and user communities. While important in their own right, these gatherings usually end up as a series of briefings to keep the larger community up to speed. On the other hand, the IPT process is what happens the rest of the time and includes the myriad of Lockheed Martin internal team working sessions as well as the equally numerous Lockheed Martin-government problem-solving meetings.

As the *acquisition reform flagship* program and pathfinder for many of the acquisition reform processes, SBIRS encounters new lessons learned on a continual basis. Internal to the contractor team, Lockheed Martin has witnessed working relationships that have been extremely productive and delivered supportability products in almost unheard of short periods of times. For example, prior to the final design review (FDR) for SBIRS Increment 1, the development of the engineering drawing package was expedited by employing the IPT process. Lockheed Martin abandoned the time-consuming method of employing a serial process in which each team member reviews the engineering drawings individually, sends comments forward to a joint meeting for adjudication, iterates the process until all issues are resolved and then sends the engineering drawings forward to a configuration control board (CCB) for final approval. In its place, Lockheed Martin gathered all of the decision makers, including product control and key working system and supportability engineers, in a *virtual forum* tied together by phone and teleconference lines so all the companies on the Lockheed Martin SBIRS team were represented. Engineering drawing set problems were identified, solutions generated in real time and corrections made as rapidly as possible. In the few cases when disagreements grew heated, the program manager, who was the IPT leader, took the parties outside the room and spoke with them individually to help reach consensus. In this way, the chaos often inherent in such a large meeting was minimized. A CCB was convened as soon as the corrections were in place, and the engineering drawing set was rapidly approved, almost without a change, because of the earlier group effort. This effort, which occurred over a 5-day period and involved more than 200 drawings, ensured a high-quality drawing package for the FDR. It could never have been done the old serial way. Even IPT skeptics were impressed by results that were obtained by this process. Supportability engineers were an integral part of the effort to ensure supportability requirements were integrated into system design from the beginning.

The familiar, almost traditional, adversarial relationship between the contractor and the acquisition and user communities is replaced in the IPT process with a working relationship characterized by extreme openness and user involvement. Supportability and specialty engineering weekly staff meetings are attended by representatives of both the acquisition and user communities to ensure requirements are satisfied, monitor development progress and resolve issues. The meeting format is a review and status of the *top ten* issues in each of the specialty engineering disciplines, logistics, technical manuals and training. All issues, even the ones that are going badly or pose risk to the program, are presented. Lockheed Martin literally *airs the dirty wash in public*—a significant paradigm shift from previous practices and relationships. Their gain from the process is the development of the quintessential IPT in that it builds new levels of trust and joint Lockheed Martin-government problem solving and issue resolution to produce a cost-effective, operational system on time and within budget constraints. The acquisition and user supportability communities are a true continual part of the Lockheed Martin SBIRS supportability engineering team.

One benefit of this process is that an extremely close working relationship grows among the government and Lockheed Martin SBIRS team members. All participants take ownership in the product. This involvement has exhibited itself in the joint resolution of supportability issues and development of key presentations by Lockheed Martin, the SPO, AFSPC and SETA personnel. It is no surprise for Lockheed Martin employees to see their peers working late nights to get a required supportability engineering product completed. The IPT process fosters Lockheed Martin employees and SETA counterparts working together for

several days and late nights to complete a project. As a team, they resolved issues and ensured that a particular supportability engineering presentation would accurately present all facets of the issue and joint resolution recommendations. Nothing in Lockheed Martin's previous experience with the acquisition process resembles this effort.

For another example of the involvement that is fostered by the IPT process, one need only look at the technical manual or technical order (TO) generation activities. Lockheed Martin has employed a standard 30 percent, 60 percent and 90 percent in-process review plan to review all developed TOs. To increase the insight of the user command into the form and content of the TOs at an early stage, they have involved a team of AFSPC operators as reviewers and developers of certain portions of the TOs (for example, high level checklists) during development and validation. Lockheed Martin and some users did not initially embrace this concept because it was felt it would be disruptive to the TO generation effort and the users did not fully understand their role under the umbrella of acquisition reform and IPTs. The SPO and AFSPC/DRFS pushed very hard for this early operator involvement, and it has proved itself to be extremely valuable. Procedures and checklists are developed by a joint Lockheed Martin TO development team and the AFSPC personnel programmed as the initial SBIRS crews. This is a superior example of a *true* IPT.

Although the IPT process can foster a contractor-government-SETA relationship on a program, there are at least two other aspects of the relationship with the government that should not be overlooked. First of all, Lockheed Martin must continually remember that these same government IPT members who jointly help to solve the day-to-day issues are also the same government employees that grade performance at award fee time. This grading process is now performed with contractor-government openness as a key criterion (usually referred to as quality of government insight) alongside the more usual ones. Although there is a risk of being penalized because of the government insight gained due to the new openness, Lockheed Martin supportability engineering has not been adversely impacted by the government's insight on SBIRS. In fact, Lockheed Martin has benefited tremendously in its efforts to deliver a supportable SBIRS. The second item in the relationship with the government is the fact that the government is a collection of nonhomogeneous agencies that do not all accept, adhere to, understand or even know of the trinity of government acquisition reform initiatives. In SBIRS experience, it has been very probable that at least one or more of the agencies with which Lockheed Martin works is still under the influence of the old acquisition paradigm or simply does not understand the significant impact of integrated supportability engineering. This situation has been eased frequently, somewhat, by those acquisition and user agencies that subscribe to and are a part of the new acquisition reform, IPT and TSPR community. This community helps enlist those recalcitrant or unknowing agencies into the new fold. Lockheed Martin, the SPO and AFSPC interface continually with these *old line* agencies to ensure good communication and requirements compliance.

In summary, several examples have been presented that show how logistics engineering activities are performed in the environment fostered by the government's new acquisition initiatives. These initiatives offer great opportunities for the use of novel and money-saving ways of developing the sustainment infrastructure in space systems. Supportability engineers will need to be flexible in their approaches to the technical effort, as well as their relationships with the customer, users and SETAs, to reap the benefits inherent in the government's new approach. SBIRS has broken new ground in the acquisition reform, IPTs and TSPR arenas. Challenges still exist, and the entire team is still experiencing varied *lessons learned* on a continual basis. SBIRS supportability engineering is an integral part of the process and contributes heavily to the successful requirements definition, design, development and deployment of the system.

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A military maxim has it that amateurs talk about strategy while professionals talk about logistics.

—Time Magazine, August 1990

Competitive Sourcing and Privatization: An Essential USAF Strategy

Lieutenant Colonel Stephen E. Newbold, USAF

Why is Outsourcing and Privatization necessary?

> The hardest things to change are institutions that have been successful and need to change anyway.
>
> —John White, Deputy Secretary of Defense

Introduction

No longer is the US faced with national survival as was the case in 40-plus years of nuclear standoff with the Soviet Union. However, in many ways, the world is far more complex than during the years of the Cold War. The Cold War bipolar alliances have given way to a world where regional interests dominate. Today, terrorism and the threat of nuclear, biological and chemical weapons proliferation—along with renewed national, ethnic and religious rivalries—dominate the international scene.

As America seeks to reap the benefits of *winning the Cold War*, the nation is faced with tough decisions regarding how much defense is needed in the *new* world. Service force structures have been rapidly reduced and weapon system inventories drastically slashed. At the same time, personnel have exited the ranks of the military in increasing numbers.

> [The] DoD's [Department of Defense] force structure today is roughly 30 percent smaller than it was in the 1980s. Our budget has also declined to about 60 percent (in real terms) of its peak in 1985.[1]

These cuts, felt by all the Services, created imbalances that must be corrected. Among these imbalances is the disproportionate growth in the *tooth-to-tail* ratio since the end of the Cold War. The tooth-to-tail issue is considered such a major concern that Defense Secretary William Cohen established a commission chartered with the responsibility of finding ways to correct the problem. In this regard, the commission was charged with finding

> . . . ways to save money in the defense *tail* portion of the budget . . . while shifting those savings to the *tooth*—warfighting segment. That ratio, nearly a 50-50 balance at the end of the Cold War, has moved so that nearly 70 percent of the defense budget now goes toward support elements.[2]

Future declining or flat-line budgets, coupled with the need to reduce the support/warfighter ratio, make changes in the support force structure and support concepts an absolute necessity.

Change, although inevitable because of budget considerations, will not be easy considering the many years of experience with largely organic support capabilities and the successes enjoyed with this approach. From the huge depot repair capabilities to base level, organic support has been the primary means for meeting Air Force mission requirements. However, it has not always been this way. In fact, today's support

> . . . activities were largely established and organized during the Cold War when [the] DoD had to depend predominately on organic support. Such support was driven by the possibility of an extended conflict with a rival superpower and a less sophisticated private, commercial infrastructure.[3]

To complicate budget and force structure imperatives, future wars are expected to be regional in nature with the US military expected to fight two simultaneous major regional conflicts. "These conflicts are often described as *come as you are* wars, meaning that there will be little lead time for mobilization or surge of production capability."[4] Additionally, today's US military plans for a more mobile and lethal battlefield. Technologically advanced weapons combined with rapid mobility will bring to bear overwhelming firepower on the enemy, creating a dramatic shock effect and producing short-duration conflict.

Today's realities—a changing international scene, budgetary difficulties, force structure imbalances and new operational concepts—demand innovative solutions that will ensure support to the warfighter is not diminished.

Competitive Sourcing and Privatization (CS&P) (formerly Outsourcing and Privatization) is essential to meeting future support requirements. Interestingly, outsourcing and privatization are really not new concepts at all. Prior to World War II, the US military routinely relied upon the private sector for much of its support. Former Secretary of the Air Force Sheila Widnall commented,

> Lest you think this is a new phenomenon, let me take you back to the era before World War II when private support was standard. It was only during the Cold War when we realized the huge buildup of government operations that we came to think of government support as the norm. In a sense, we're going "back to the future."[5]

The Air Force must pursue CS&P, using the savings for modernization and procurement to meet future needs. However, care must be exercised in making CS&P a reality, or it may undermine warfighting capabilities. A well thought-out and deliberate implementation strategy is crucial to success.

Converting from an in-house to a contractor-provided workforce is a lengthy and complex process. Rules and regulations abound, making the process difficult to understand. To take full advantage of the benefits of outsourcing and privatization, there must be relief from many of the restrictions currently in place. Further, there must be acceptance and support at all levels of the Air Force for the initiatives involved under CS&P. Transitioning to a

predominantly contractor-provided support force may seem a bitter pill to swallow to many, especially since the in-place organic workforce has traditionally provided quality and responsive support to the needs of the warfighter. However, the existing fiscal demands and budgetary imperatives offer few alternatives. To understand the need, it is first important to understand the terminology, in order to establish a level of common understanding.

Key Terms Defined

Only those functions considered commercial activities are eligible to be performed under contract. By definition, "A commercial activity is the process resulting in a product or service that is or could be obtained from a private source."[6] However, just because a particular function fits the commercial activities definition does not automatically make it a *contracting candidate*. There are several valid reasons to exempt an otherwise commercial activity from being performed by contract and, conversely, valid conditions to convert a government function to one that is contractor operated. Under CS&P, the government is allowed to perform an otherwise commercial activity when the function is considered a core capability. A core capability is defined as:

> A commercial activity operated by a cadre of highly skilled employees, in a specialized technical or scientific development area, to ensure that a minimum capability is maintained. The core capability does not include the skills, functions or FTE [Full Time Equivalents] that may be retained in-house for reasons of national defense, including military mobilization, security, rotational necessity or to patient care or research and development activities.[7]

There are also some areas that are considered organic functions of the federal government that are exempt from CS&P initiatives. The term *inherently governmental activity* is applied to those areas in which performance by a commercial contractor does not serve the interests of the nation because of the nature of the work itself. It is "an activity that is so intimately related to the public interest as to mandate performance by federal employees."[8] Typically, functions fall in this category because of the government's responsibility to the taxpayers. A contracting function or a government audit function is a typical example of an area that is considered inherently governmental.

Competitive Sourcing and Privatization Savings

The DoD's experience with outsourcing seems to confirm that savings are substantial when comparing organic to contract support.

> Cost comparisons conducted between 1978 and 1994 show savings of about $1.5B a year. The military departments and defense agencies that took advantage of outsourcing via competition have reduced their annual operating costs by about 31 percent.[9]

Similarly, within the Air Force, outsourcing has saved an estimated $500M a year according to Colonel Michael A. Collins, former Chief of the Air Force Outsourcing Office.[10] Further, the Defense Science Board Task Force on Outsourcing and Privatization estimated "savings of up to $7B to $12B annually by Fiscal Year 2002 . . . ."[11] It is important to note, however, that both actual and projected savings are somewhat suspect according to the General Accounting Office (GAO). In testimony to Congress, the GAO noted that it has been unable to substantiate the savings claimed by the DoD for a variety of reasons. Among the reasons are generally poor cost-capturing procedures within the DoD and a noticeable trend in cost growth in established contracts.[12] Unlike private industry, the DoD is not a profit-making enterprise. As a result, managing costs has historically not been a strong suit for the defense establishment. As it tries to capture costs associated with a particular activity, the DoD's limited cost-managing experience makes the effort difficult and the results somewhat suspect. Similarly, the DoD's experience in writing service contracts has frequently resulted in contract modifications to the original contract, which routinely adds workload to the contract and increases costs. The cost savings claimed by the DoD under CS&P come exclusively from comparisons with initial contracts and not those that have been modified.[13] Recently, the GAO was tasked to review existing contracts to determine the actual cost growth.[14] In spite of the GAO claims of inconclusive cost savings, the available evidence as highlighted by the Defense Science Board and others makes a strong case for outsourcing and privatization.

One of the areas severely impacted during the defense drawdown has been procurement. Funding for procurement has fallen well below the levels needed to replace older weapon systems and ensure a technological advantage.

> Over the next five years, the military will have to nearly double its spending on weapons, pouring $67B a year into new planes, ships and other weapons to replace those that are wearing out and to maintain technological superiority on the battlefield.[15]

"In terms of 1996 dollars, procurement has fallen from a peak of $126B in 1985, to just $39B in 1996—a reduction of 69 percent."[16] The savings to be generated by competitive sourcing and privatization offers one avenue to reduce procurement funding shortfalls.

The Process

The Office of Management and Budget Circular A-76, Performance of Commercial Activities, is the cornerstone document for CS&P guidance and is fundamental to cost comparisons between the government and the private sector. The A-76, appropriate federal and DoD acquisition regulations and public laws provide the basis for undertaking the outsourcing decision. The first step in the process is to identify the potential candidates for outsourcing. Next, a Performance Work Statement (PWS) is prepared. The PWS provides the foundation for the entire process.

> The PWS defines what is being requested, the performance standards and measures, and timeframes required. It provides the technical performance standards and measures and timeframes required. It provides the technical performance section of the Request for Proposals (RFP).[17]

Simply put, the PWS defines what work is to be done, the timelines for its completion and the standards expected. The PWS should provide flexibility to the performing activity on how to meet job requirements. This flexibility and a properly written contract will normally result in the contractor's identifying and employing improved efficiencies.

The Quality Assurance Surveillance Plan is the government's oversight plan for the contract and is used to determine contractor performance. This plan "describes the methods of inspection to be used, the reports required and the resources to be employed with estimated work-hours."[18] The QASP provides the *report card* on how well the contractor performs and provides the basis for payment incentives associated with the contract.

Since the essence of the A-76 process is to determine the most effective method—government or contractor—to perform the identified activity, the government must also prepare a bid for the work. The result of this process is the Management Plan.

> The Management Plan describes the government's Most Efficient Organization (MEO) and is the basis of the government's in-house cost estimate. The Management Plan, which must reflect the scope of the Performance Work Statement, should identify the organizational structures, staffing and operating procedures, equipment, transition and inspection plans necessary to ensure that the in-house activity is performed in an efficient and cost effective manner.[19]

The Management Plan provides the government with a cost basis for performance of the work and is essential to the competition process.

The solicitation process offers the opportunity for the private sector to bid for the work in competition with the government, with the PWS providing the basis for the work to be performed. The Federal Acquisition Regulation (FAR) provides explicit guidance on the solicitation process. For example, FAR, Part 7 requires confidentiality of the government cost estimate until the most advantageous contractor proposal has been determined.[20] Solicitations must provide open and fair competition, resulting in the best overall value for the government. Once the solicitations have been received, the appointed source selection authority makes the final determination regarding whether to accept the in-house government bid or a bid from the private sector. There is also an appeals process to satisfy any complaints from prospective or unsuccessful bidders.

The Private Sector Experience

Taken together, outsourcing and privatization are viewed as a primary way of doing business in the private sector and are important ingredients for long-term corporate success. The competitive forces in the US economy drive businesses to look for the most cost-efficient and cost-effective means of delivering their products. As a result, the scope of outsourcing within the private sector has grown widely in recent years. For example, one estimate projected private industry spending of $100B on outsourcing in 1996 with savings estimated between 10 to 15 percent.[21] There are a variety of ways in which cost savings are generated in the private sector. According to Defense Science Board findings, the savings can generally be described as coming from five main areas: (1) a lower cost and more flexible work force, (2) more efficient business practices enabling staff reductions, (3) more efficient utilization of facilities and equipment, (4) cost avoidance in infrastructure and (5) smaller inventories.[22] In addition to the monetary savings and cost avoidance, there are additional reasons that motivate business to outsource.

Outsourcing allows corporations to focus on their *core activities*. This allows them to direct their energies toward those areas they consider fundamental in order to capitalize on competitive advantages. Functions necessary for conducting business, but not necessarily considered a core activity, are prime candidates for outsourcing. However, what is not considered a core function for one organization is, or at least should be, the core competency of the company seeking to obtain the contract work. It is important to note that no business, no matter how large or diverse, is able to organically provide all necessary resources to render final product delivery.[23] Specialization is a key to success. By specializing, a company can focus on fewer areas and, therefore, is able to identify and capitalize on opportunities.

"Specialization, whether of labor or capital, facilitates optimal use of inherent or acquired traits, saves time by focusing on a limited number of tasks, encourages job mastery and spurs on innovation."[24] Large, diversified organizations simply cannot respond to the market demand as well as less diversified ones.[25]

Another outsourcing benefit seen is *improved service* to the customer. This is evident in the overall quality of the service provided, the responsiveness to the need and the agility of the service provided.[26]

Outsourcing also enables companies to *gain access to technologies* that might not otherwise be available.[27] This benefit is closely related to the core activity advantage. Generally, large, complex organizations are far less capable of taking immediate advantage of technological advances, especially in non-core areas. For example, a company that relies heavily on computer support but is not in the computer hardware or software business itself may find it beneficial to outsource its computer-support needs.

Outsourcing can also be used to generate *operating capital* for the organization. By divesting itself of a particular non-core function, a company can liquidate assets.[28] Obviously, if there is no need to provide the support organically, there is no need to retain assets required to do the work. The funds from the sale of these assets become available for other purposes or to support core functions. Depending upon the function in question, this can amount to a large sum of money. The amount of capital generated generally corresponds to the function that is outsourced.

Establishing and Managing the Contract

Establishing a contract within the private sector is fairly straightforward. As a result, the private sector takes significantly less time, on average, to establish a contract than it takes within the government. In fact, "outsourcing timelines in the private sector average about 15 months—less than half the DoD average."[29] The reasons for this situation relate primarily to the extensive bureaucratic process within the federal government. The private sector has fewer contracting restrictions than the government. It not only takes less time but also takes a significantly different view of contracting in general. Market forces and profit dominate the private sector view of contracting, and together they produce a different motivation. Within the private sector:

- Businesses increasingly raise their standards for qualified suppliers. This serves to restrict the pool of suppliers to the best available. Firms then deepen and broaden this relationship with these suppliers.
- Some companies experience fraud and abuse in their outsourcing activities. However, the private sector is learning to overlook such problems when elimination is not cost effective.
- Increasingly, private sector enterprises emphasize performance over cost, giving increased attention to subtleties of performance that may be difficult to justify objectively. Ultimately, this approach is far more cost effective, even if the products or services purchased are more costly.[30]

Private sector experience with outsourcing within the aircraft support industry offers a particularly good benchmark for the Air Force since many functions are similar. Outsourcing in this industry is now commonplace. In fact, 15 to 20 percent of all the required maintenance is now outsourced with the figure expected to grow.[31] Interestingly, there is a notably different approach to outsourcing when comparing the older, more established companies with the younger ones within the industry.

> Major airlines can be divided into two groups: younger airlines that have emerged after the late 1970s (the era of airline deregulation), which outsource virtually all of their depot-level maintenance, and the older, established airlines that maintain most of this workload in-house. All major carriers maintain an internal line ('O-level') maintenance capability.[32]

The reason for the differing approaches is straightforward and primarily dependent on the infrastructure capabilities of older airlines developed over the years. Also, labor unions and corporate culture are important in the outsourcing decision. The established

> . . . airlines have created an extensive maintenance infrastructure and have strong economic incentives to fully utilize these facilities. Union agreements often prohibit outsourcing of work that can be performed by company employees. In many airlines, the corporate culture also plays a role in discouraging full-scale outsourcing.[33]

Within the airline industry, companies typically look for a long-term relationship with a contractor. This not only provides stability but also produces a partnership-type approach to the business relationship. Five- to ten-year fixed-price contracts are the norm with the rates negotiated annually.[34] In the case of poor performance, contracts can be quickly terminated. Also, airlines have found a means to more directly tie compensation to performance based on the reliability of contractor provided components. Although this approach, known as *power-by-the-hour*, does not necessarily *fit* all aspects of airline aircraft maintenance, it does offer substantial advantages in some areas, and its use is becoming more common.

> Power-by-the-hour (PBTH) arrangements are growing in popularity. Under this approach, the airline contracts for performance, rather than a specific repair, and the vendor assumes material management responsibility for the item. PBTH provides airlines with greater maintenance cost stability and predictability, reduces inventories, and gives vendors strong incentives to improve reliability. PBTH arrangements are most prominent in engines, auxiliary power units, landing gear and tires.[35]

Challenges for the Air Force

As the Air Force embraces CS&P on a much broader scale, it must overcome many challenges. First, the process needs

Citation	Summary	Citation	Summary
Title 10 US Code Section 2461	Mandates extensive reporting to Congress, including cost-comparison study prior to outsourcing.	Title 10 US Code Section 2469	Depot maintenance work >$3M may not be outsourced without public/private cost comparison.
Title 10 US Code Section 2464	Logistics requirements defined as *core* cannot be outsourced.	Sec 8020 Fiscal Year 96 Appropriations Act	Requires MEO analysis of all functions of >10 DoD civilian employees before outsourcing.
Title 10 US Code Section 2465	Prohibits outsourcing of civilian firefighting or security guard functions at military bases.	Sec 8043 Fiscal Year 96 Appropriation Act	No funds for A-76 studies which exceed 24 months for 1 function or 48 months for >1 function.
Title 10 US Code Section 2466	Limits outsourcing of depot maintenance to 40 percent of total.	Sec 317 Fiscal Year 87 Authorizations Act	Prohibits contracting any function at McAlester or Crane Army Ammunition Plants.

Table 1. Governing Directives[37]

streamlining. It simply takes far too long to outsource or privatize an activity. Furthermore, the more complex the function, the longer it generally takes to perform the assessment. The process requires single-function awards to be completed within 24 months and multifunction awards within 48 months. Studies exceeding these established time lines require justification as to why the delays occurred and must be submitted to the Office of Management and Budget.[36] Extensive legal considerations also significantly contribute to making the outsourcing process unwieldy. A macro review of the statutory provisions indicates they undermine the Services' abilities to outsource or at least place formidable roadblocks, thus making outsourcing difficult to accomplish. Table 1 highlights the restrictions and provides a summary of the key issues involved.

It certainly can be argued that most, if not all, of the legal provisions were put in place to safeguard the expenditure of public funds. However, in light of the current emphasis to implement improved business practices within government and to streamline government operations, change must be made. Collectively, the statutory provisions restrict the flexibility of the Services in making outsourcing decisions.

> The statutes . . . increase the involvement of Congress in outsourcing decisions and expand opportunities for Congressional micromanagement; require extensive Congressional notifications and reporting, including the preparation of exhaustive cost analysis studies; impose arbitrary limits on the share of depot-level maintenance workload that may be outsourced to private contractors; and establish arbitrary exemptions from outsourcing of selected functions such as fire safety and physical security. Moreover, the history of Congressional reaction to past DoD outsourcing initiatives has a *chilling effect* on DoD activities that are considering contracting out other workload. Taken together, the current legal environment encourages the politicization of the outsourcing decision process, and thereby complicates, delays and discourages DoD efforts to increase its reliance on private vendors for support services.[38]

Although statutory relief is certainly needed in many areas, there are several DoD in-house issues that must also be addressed. Support for CS&P initiatives within the Air Force may be difficult to obtain. Outsourcing and privatization, at both the conceptual level and implementation level, conflicts with the well-established Air Force cultural grain and represents a marked departure from the traditional way of doing business. Considering that defense employees are generally conservative and not prone to taking risks, contracting the workload will be difficult to accept.[39] Resistance to change, especially the magnitude expected with CS&P, is not unusual, no matter what the institution.

> Large, successful organizations typically institutionalize and thereby preserve the successful values and procedures that define the status quo. DoD is no exception. Where organic supply exists, DoD organizations will resist any large change, no matter how desirable.[40]

Even more important is the concern that contractors will not provide needed support during contingencies or wartime operations.[41] No doubt readiness and wartime support are valid concerns; however, the Air Force does not plan to outsource areas that affect essential military skills or those functions that are inherently governmental. Essential military skills are those that:

- Directly contribute to combat or combat support.
- Must be filled by military members by law, such as firefighters and security guards.
- Are military by custom or tradition, such as bands or honor guards.
- Are needed to support overseas rotations.[42]

This is a reasonable approach; however, the restrictions prohibiting the outsourcing of firefighters and security guards need to be eliminated. In addition, there needs to be a clear delineation concerning what areas contribute directly to combat or combat support. On the surface, this may seem straightforward, but in reality, it is difficult to define. For example, the fighter pilot flying combat sorties directly contributes to combat. But what about the in-theater aircraft maintainers, transporters and supply personnel? It is precisely this area regarding support personnel where the definition becomes decidedly fuzzy. A reasonable approach is to retain organic support for all those areas required for mobility.

During contingencies and even during the open hostilities of war, contractor support has traditionally been essential for many key aspects of the US military. For example, contractors were employed extensively in the theater of operations during DESERT SHIELD/DESERT STORM and today provide key base support functions for several ongoing operations. While contract support during times of contingency has been common, the criteria for those areas where contract support is both feasible and practical must be further defined. Once this is done, the military needs to work with the contractors during peacetime to ensure uninterrupted support during actual contingencies.[43]

In spite of initiatives to change how the DoD deals with contractors, significant change is still required. Too often there is a general lack of trust on the part of the government as to how the contractor will perform the contract. In this regard, the "DoD often fosters adversarial relationships with contractors rather than the needed partnership."[44] One reason is the intrusive oversight the government maintains over contractors. This oversight is the result of a few bad experiences. The government's answer to fraud has typically been more bureaucratic oversight of the process, penalizing all when only a very small minority of contractors are involved.[45] This is not to say that fraud should be overlooked. As advocated by RAND,

> When individual incidents (fraud) occur, the response should not be to revisit the procurement regulations but to punish the perpetrator heavily enough to provide a deterrent for others in the future. That is, enforcement should focus on the isolated wrongdoers when they are caught and not on the activity of contracting as a whole.[46]

In addition, the Air Force needs to rethink how it structures the contracts. Performance-based contracts offer advantages to both the government and the contractor. By focusing on results rather than how the work is accomplished, the contractor is better able to find efficiencies, which result in cost savings for the government, while still providing the level of service desired. While there certainly must be restrictions governing how some critical tasks are performed, even in these areas, there are opportunities to improve efficiency.

The Air Force also needs to be more creative in how it provides incentives to the contractor. For example, the Air Force could make good use of the PBTH methodology mentioned earlier. This approach is particularly suited for current and potential aircraft maintenance contracts. PBTH does an excellent job in directly tying performance to compensation.

Conclusion

CS&P offers the Air Force potentially large savings that can be directed to critical procurement shortfalls. Clearly, there will have to be a culture change within the Air Force in order to overcome tremendous resistance to change. Just as clearly, CS&P initiatives must not compromise our warfighting capability. In this regard, identifying core functions that should not be outsourced or privatized is critically important and is an area that the Air Force has yet to fully address. Congressional support is needed for relief from arbitrary outsourcing restrictions as well as the excessive reporting and oversight requirements presently imposed. Finally, the Air Force must exercise care in how it pursues outsourcing and privatization. The Defense Science Board's recommendation is to contract as much as possible as quickly as possible, but this could lead to overall disaster. In commenting on this point RAND said,

> . . . the Commission implicitly promotes a rapid program of outsourcing that could lead to early failures. That is, if DoD pursues extensive expanded outsourcing without giving such factors adequate attention, it could fail to realize its expectations about performance and reduced costs. Such failures could discredit the notion of expanded outsourcing before such outsourcing has a chance to prove itself.[47]

A more measured approach based on a well-conceived strategy will better serve the long-term needs of the Air Force.

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JL

New Logistics Assignments Branch Telephone Numbers

Community	Old DSN	New DSN	Old Commercial	New Commercial
Maintenance	487-3556	665-3556	(210) 652-3556	(210) 565-3556
Log Plans	487-5788	665-2485	(210) 652-5788	(210) 565-2485
Supply	487-6417	665-2684	(210) 652-6417	(210) 565-2684
Transportation	487-4024	665-4024	(210) 652-4024	(210) 565-4024

Providing Responsive Logistics Support: Applying LEAN Thinking to Logistics

Norman H. Patnode

Let's look at the age-old problem of logistics—to support and sustain the warfighting mission. In order to satisfy this, the logistics system (supply, repair, production, transportation, etc.) must provide customers with what they need when they need it. It must also minimize the cost to the customer.

What is needed to satisfy each of these requirements? In order to provide customers what they need when they need it, the logistics system must repair, produce or purchase things based on forecasted demands. However, in order to minimize the cost to the customer, the logistics system must repair, produce or purchase only what the customers requests and only when they ask for it.

Obviously we have a conflict—we cannot execute (repair, produce or purchase) based on forecasted customer demand and execute based on actual customer demand. The problem is real and has existed since time immemorial. The question before us now is whether we can find a solution to the problem. Let's look at the conflict as it is diagrammed in Figure 1.

A paradox exists when there is a conflict with no apparent solution. Both sides seem to have a logical position but seemingly opposite conclusions. Typically, we compromise in this situation. We repair, produce or purchase things based on a forecast. When the forecast falls short, we frantically attempt to satisfy the urgent backorders. As a result, customers do not get what they need when they need it, and we never completely minimize the costs to our customers.

A better approach is to challenge the assumptions behind the arrows in Figure 1—assumptions that bind the entities together to form the conflict. If we can remove an arrow by invalidating an underlying assumption, the conflict evaporates.

Using Figure 2, let's examine some assumptions. We get to the assumptions by asking why the tail of the arrow is necessary in order to have the tip of the arrow.

Since it is unlikely that we can eliminate the variability in the logistics process (repair, produce or purchase) or even the uncertainty in the customers' demands, we must continue to forecast or find some way to protect our customers from the effects of the variability.

What if we always had enough stuff on hand to send one to the customers whenever requested? If we could do that, we could stop executing to our forecast. We could simply make replacements through repairing, producing or purchasing. There would no longer be a conflict—the customers would get what they need when they need it, and we would not spend a penny on stuff the customers did not need *now*. This could work. But how do we make sure we actually have enough stuff to protect our customers from the variability, and what happens if we do not?

Let's take the second question first. Take another look at Figure 2. As long as the uncertainty in the customers' demands and the variability in the repair, production or purchasing process continue to impact the customers, the need for forecast-based execution continues to exist. So if

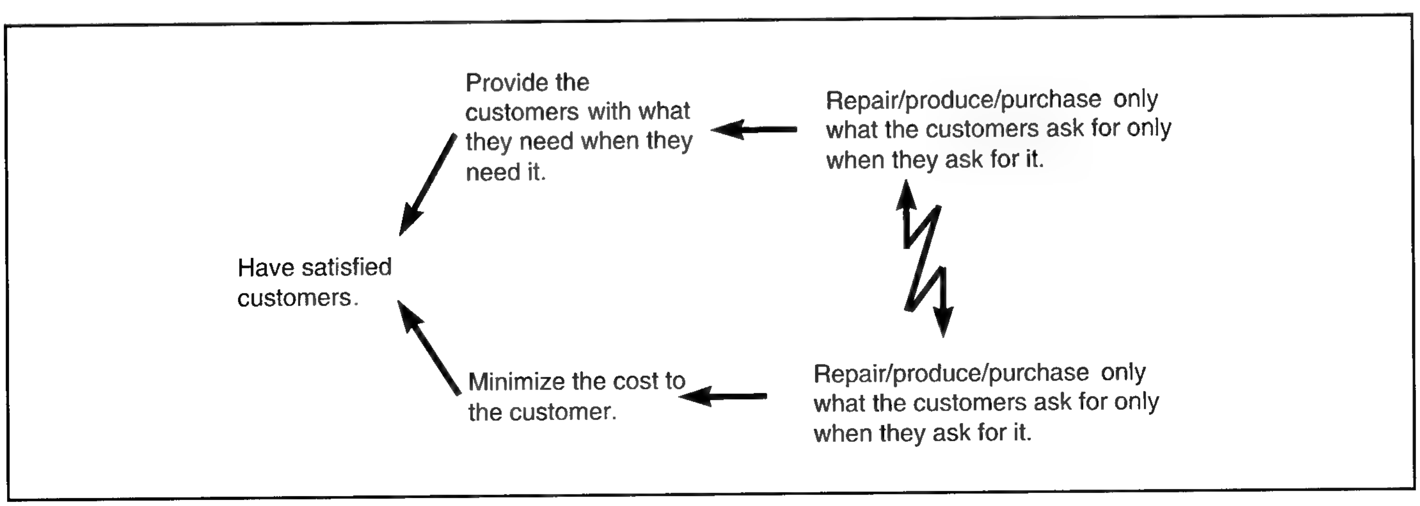

Figure 1. The Logistician's Paradox

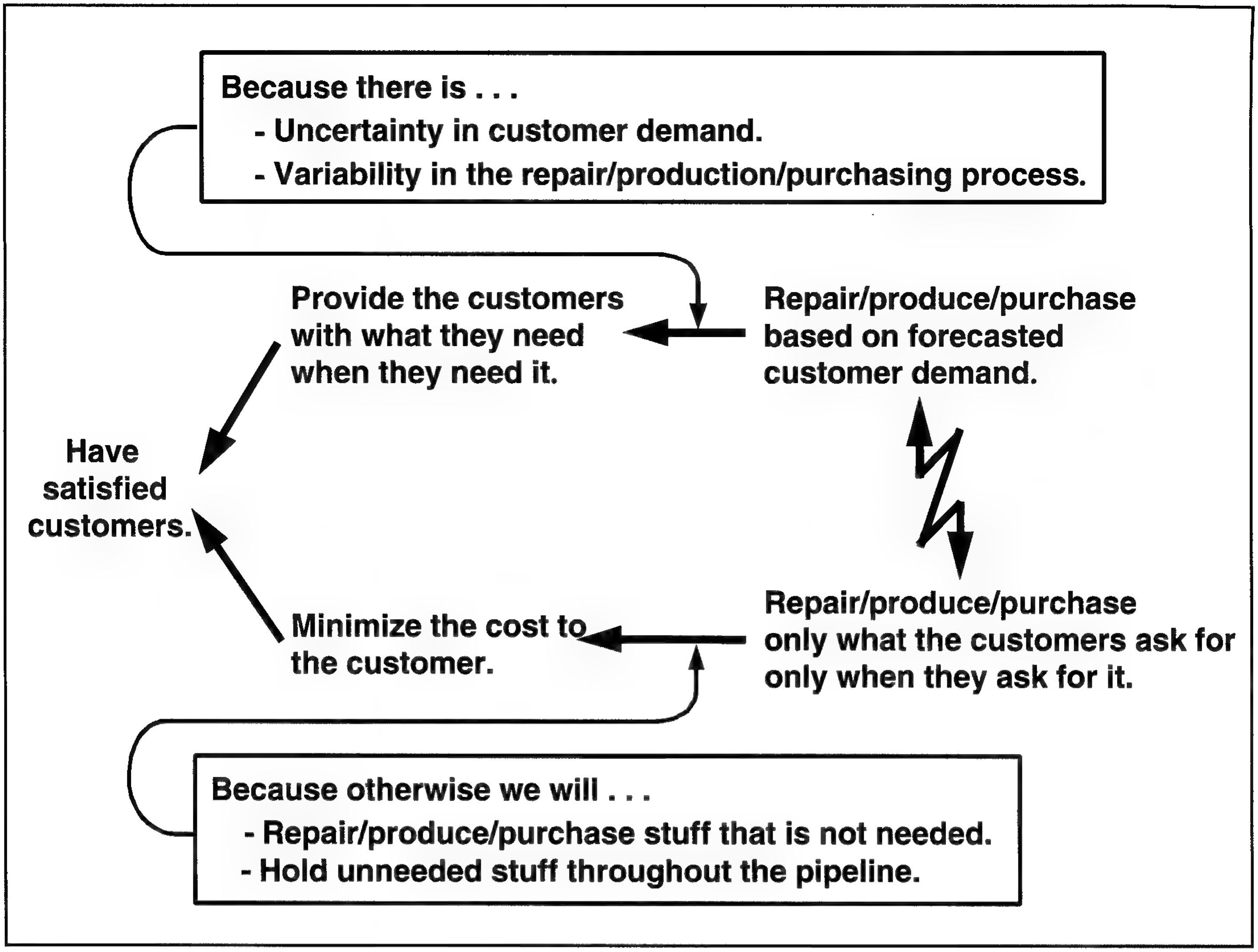

Figure 2. The Underlying Assumptions

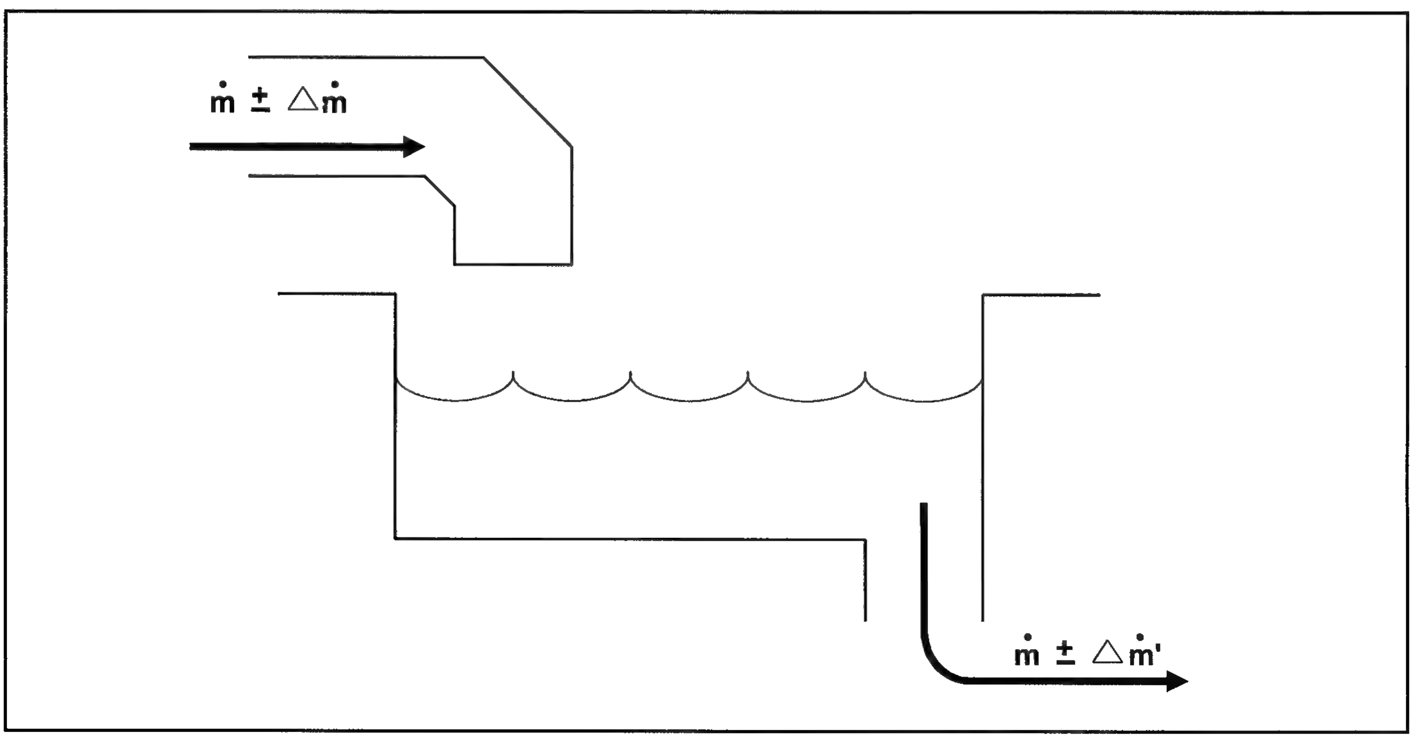

Figure 3. The Protection Buffer

we fail to adequately protect the customers from the variability in the logistics process and we attempt to repair, produce or purchase based on actual real-time customer demands, the customers will not get what they need when they need it. They will always have to wait the full lead time. In short, we will fail to meet the customers' needs.

If we embrace demand-based execution but fail to ensure customers are adequately protected from the variability in the logistics process, we are guaranteed to fail as logisticians.

So let's go back and tackle the first question: How do we make sure we actually have enough stuff to protect the customers from the uncertainty in their demands and the variability in the logistics process?

The first step is to quantify the variability. Then we must decide how much protection is needed. Do we really need to protect against 100 percent of the variability, or is 80 percent good enough? It is a management function to weigh the *cost of protection* against the *impact on the organization's goals.* Finally, we need to continually check to see if the level is providing the needed protection and adjust it as necessary.

Imagine a swimming pool with a pipe feeding in water and a pipe draining water. The input pipe has some average rate of flow with some amount of variability around that average. The output pipe has the same average rate of flow but also has some amount of variability around that average. The variability in the output flow rate is not necessarily the same as the variability in the input flow rate. This is shown in Figure 3. This is your protection buffer. The challenge is to keep enough—and only enough—water in the swimming pool to keep the output pipe from sucking air. Let's take a look at how this can be done. Recall the first step is to quantify the variability as shown in Figure 4.

By looking at the serviceable on-hand balance (the water level in our swimming pool) for our 25-day period, we see that the smallest balance is minus nine assets. (In other words, there are nine unsatisfied customer requirements.) In our example, we said we do not ever want the output pipe to suck air, so we set our level to protect against *all* of the threatening variability. The initial level in our swimming pool needs to be nine assets. (If we choose to protect against only 89 percent of the variability, then we would set the level to be eight assets.)

Remember the final step: continually check to see if the level is providing the needed protection and adjust it as necessary. This is easy, too. Just continue to measure the serviceable on-hand balance and, on a regular basis, set the new level by subtracting the smallest serviceable on-hand balance from the old level. Or in equation form:

$$\begin{pmatrix}\text{New Level}\\\text{Required}\end{pmatrix} = \begin{pmatrix}\text{Percent}\\\text{Protection}\end{pmatrix} \times \left\{\text{Old Level} - \begin{pmatrix}\text{Smallest Serviceable}\\\text{On-Hand Balance}\end{pmatrix}\right\}$$

Note that in order to keep the right amount of water in the swimming pool, it is not necessary to know how long either of the pipes are or what connected them.

The same holds true for any logistics process. By simply watching the serviceable on-hand balance in our protection buffers, we can make sure they provide the required level of protection to our customers.

If our customers are adequately protected from the variability, then we can remove the arrow in the Logistician's Paradox, which requires us to forecast. From Figure 5, we see that our solution eliminates the conflict and creates the opportunity for us to truly minimize our cost to the customers by only repairing, producing or purchasing what they request when they ask for it.

But are we missing something? What if we do not have enough assets to fill our protection buffers to the levels needed to protect the customer? Would not that mean, despite all these great ideas, we are still stuck in the conflict. Are we still in a paradox?

In short, yes. But there is a way to get around this dilemma. Let's take a look at something called the Square Root Law, which we can use to increase the protection to our customers, without increasing our requirement for assets.

Today, many of us use forecasts to determine how many assets we need at each location of our distribution system. The Square Root Law makes use of the statistical fact that the accuracy of a forecast increases as you increase the size of the forecast population. (That is why group health and life insurance is so much cheaper than individual policies. As you aggregate the individual forecasts into a group forecast, the forecast becomes more accurate.) As shown, the Square Root Law defines how much better the forecast gets as you aggregate the individual forecasts.

$$\begin{pmatrix}\text{Accuracy of the}\\\text{Aggregate Forecast}\end{pmatrix} = \begin{pmatrix}\text{Accuracy of the}\\\text{Individual Forecast}\end{pmatrix} \times \sqrt{n}$$

where n is the number of individual forecasts.

This says if we consolidate 25 locations the forecast is 5 times more accurate.

Let's return to our protection buffers. They are set to protect against the forecasted variability. (We are assuming future variability will look like past variability.) Placing assets at a number of forward distribution centers to provide protection buffers at each location requires more assets than placing the protection buffer at the source of supply (repair, production or purchasing) and using fast transportation to get them to the customers when needed.

Input Pipe (Receipts)	2	0	3	0	0	0	1	0	3	0	0	0	0	0	0	0	4	0	1	0	1	1	0	5	0
Output Pipe (Requests)	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	9	0	0	0	1	0	1	1	0	9
Serviceable Assets On-Hand	2	2	5	5	5	5	6	-3	0	0	0	0	0	0	0	-9	-5	-5	-4	-5	-4	-4	-5	0	-9

Figure 4. Quantifying the Variability

How many more assets are we talking about? The Square Root Law says:

$$\begin{pmatrix}\text{The assets needed}\\ \text{for individual}\\ \text{protection buffers}\end{pmatrix} = \begin{pmatrix}\text{The assets needed}\\ \text{for a centralized}\\ \text{protection buffer}\end{pmatrix} \times \sqrt{\begin{pmatrix}\text{The number}\\ \text{of individual}\\ \text{protection buffers}\end{pmatrix}}$$

If we choose to establish individual protection buffers at 25 locations for a given item, it will take 5 times more assets than would be needed to establish a consolidated protection buffer at the source of supply. For a given number of assets, a consolidated protection buffer would provide all the locations with 5 times more protection than would be possible if 25 individual protection buffers were established.

Sounds great, right? Well, before we sign up, let's examine the two assumptions on which the Square Root Law is based:

- Demands at each location are uncorrelated.
- The variability of demand is the same at all locations.

If the assumptions are valid, the Square Root Law holds. As the validity of the assumptions degrades, the benefit gained from centralizing the protection buffers decreases.

We are not talking about stripping all of the assets from the forward distribution centers and putting them in consolidated protection buffers. We are only talking about the assets needed to protect the customers from variability—safety stock. The requirement for assets to fill (the *average* portion of) the pipelines will still exist, although it should decrease as we use fast transportation to shorten the average length of our pipelines.

However, the Square Root Law clearly shows the benefit of consolidating the safety stocks, especially if it is done in combination with the creation and active management of protection buffers to allow us to execute based on actual real-time customer demand.

At this point, we start to see that *leaning* our logistics process requires us to implement an integrated solution. In addition, the consequences of failing to implement a piece of this integrated solution should be obvious. For example, we now understand that attempting to implement a demand-based logistics process without establishing and managing protection buffers does not solve the conflict represented in the Logistician's Paradox.

Let's continue by examining each piece of our lean solution and how they fit together to form an integrated lean logistics process.

Establish Consolidated Protection Buffers

As we have already seen, it is essential that we establish protection buffers if we are to loosen ourselves from the grip of the Logistician's Paradox. Prudence then directs us to consolidate those protection buffers whenever possible to benefit from the reduction of assets required to protect the customers. It is not enough to just establish protection buffers. It is essential that we continually measure the variability in our logistics process and adjust our protection buffers as needed to ensure our customers are protected from the effects of that variability.

Execute Based on Actual Customer Demands

With the establishment of protection buffers, we can safely move to demand-based execution of our logistics process. If the resources do not exist to satisfy all of the customers' requirements, then we prioritize those requirements and draw a cut line.

Once it is determined each day which requirements will be satisfied, each of those requirements becomes a demand on a protection buffer. If serviceable assets are available, they are immediately shipped to satisfy the customer requirements.

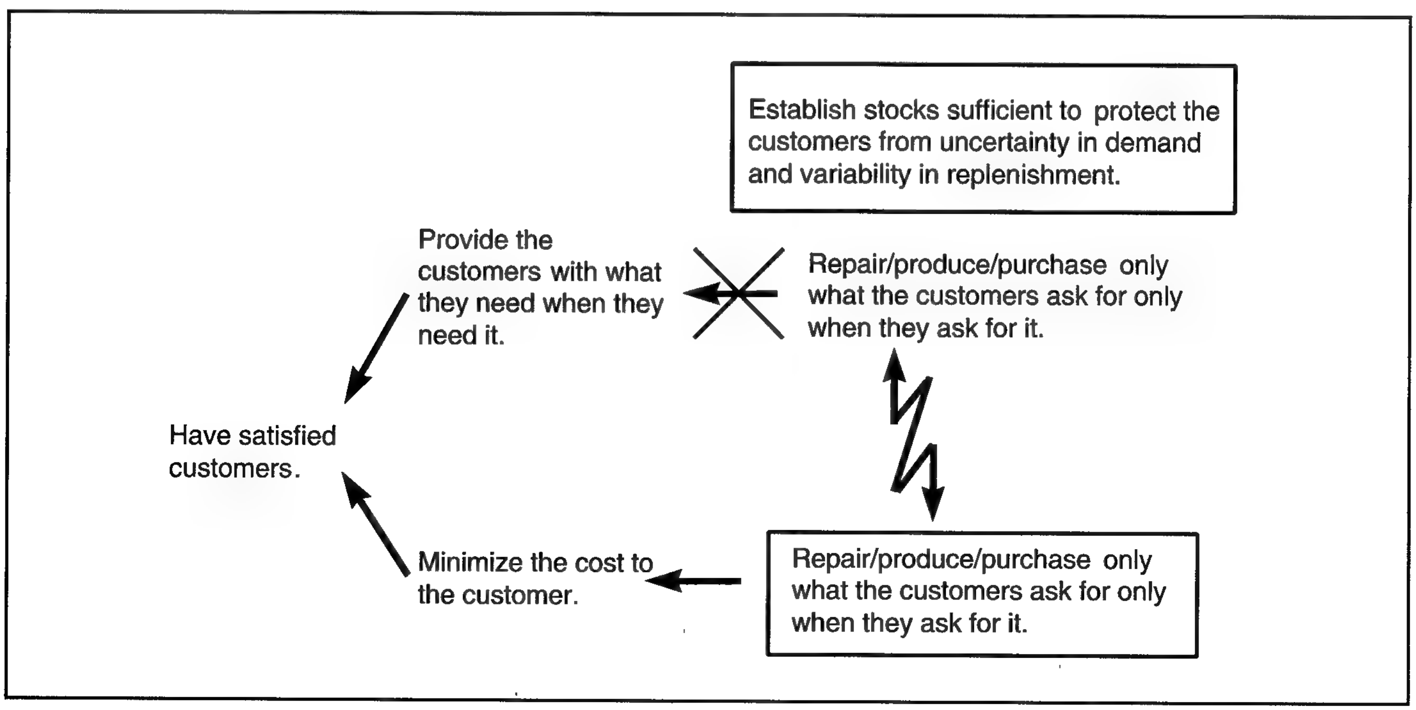

Figure 5. A Way Out of the Paradox

If not, then the serviceable assets are shipped as soon as they become available. To keep the flow of assets balanced, whatever number of customer requirements is to be satisfied, the same number of assets must be put into the logistics process. (The only exception would be if we made a change to the size of a protection buffer.) This is accomplished using a pull, pull, pull process. Here is how it works:

To those in the process upstream of the consolidated protection buffer, each demand placed on the consolidated protection buffer is viewed as a *hole*. Because they are graded on how long they take to fill each hole and by how much stuff is in their part of the pipeline, they work hard to make sure none of their protection buffers go *negative balance* (zero is acceptable in many cases) and to minimize the amount of stuff in their part of the pipeline.

When a demand is placed on the consolidated protection buffer, those responsible for *feeding it* reach back into their *assembly buffers* to get what they need to produce a serviceable end item which will satisfy the demand. Those components that were removed from an assembly buffer to produce the end item further pull on the logistics process by creating holes in the assembly buffers. Similarly, those responsible for feeding the assembly buffers reach back into their *parts buffers* to get whatever they need to produce the components needed to fill the holes in their assembly buffers. In turn, this creates holes in the parts buffers, which pulls on those responsible for feeding the parts buffers.

This process of pull, pull, pull ensures the flow of assets is maintained. It synchronizes the efforts and resources of the entire logistics process and greatly simplifies the operating rules for those working in the logistics process.

Eliminate Queue or Wait Time

Take a process and ask, how long does it take to complete it—what is the *total process time* from start to finish. If we dissect the total process time, for nearly any process, we will find that 8 to 12 percent of the total process time is hands-on time. The rest is queue time—time where the work is just sitting and waiting. Now apply the Pareto principle and ask, where should we focus our process improvement efforts? Does it really make sense to spend money on new technology so we can put the paint on a widget in 3 minutes instead of 5, if those widgets sit for 3 1/2 weeks before they go into this paint booth?

(Continued on bottom of page 41)

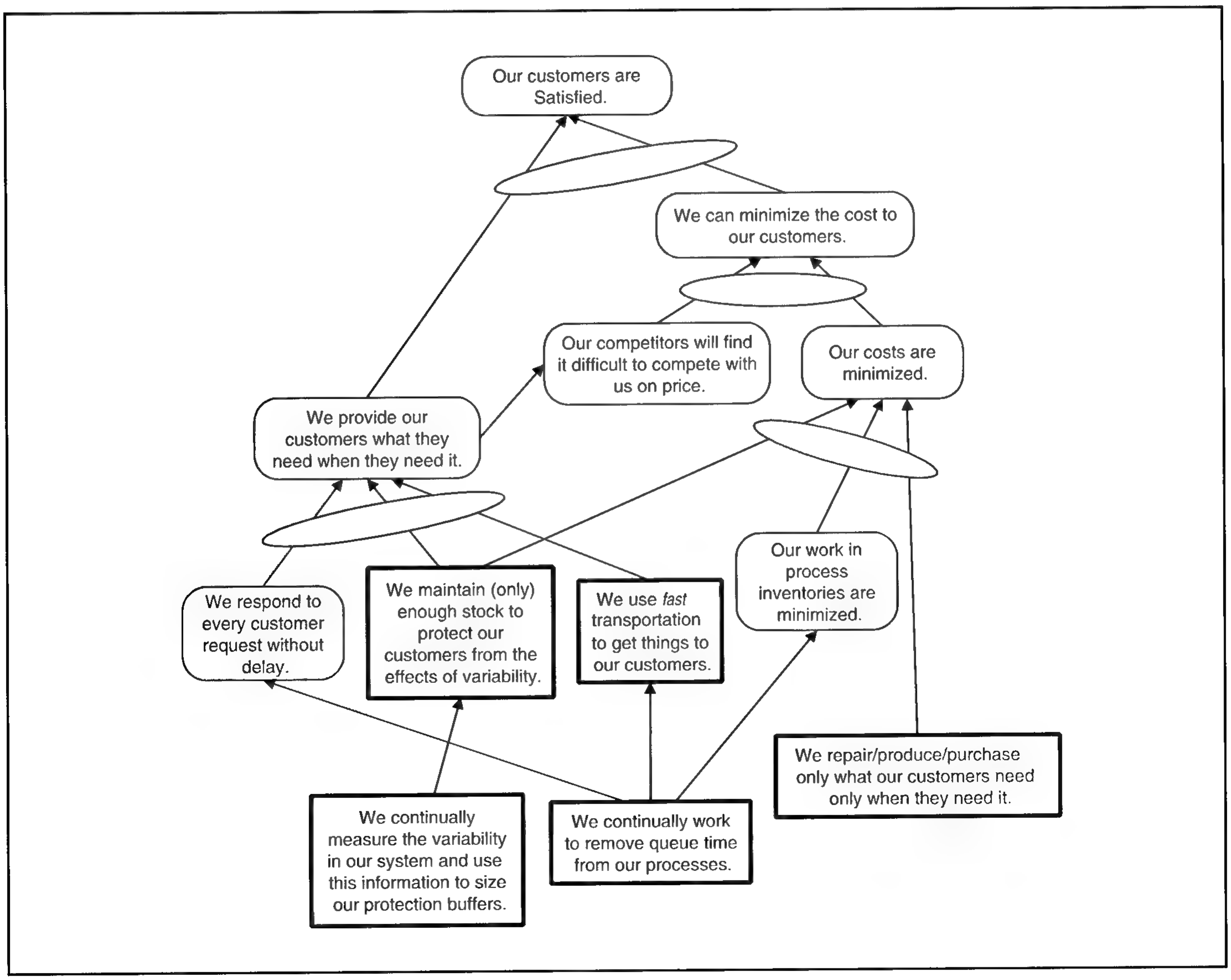

Figure 6. Putting All the Pieces Together to Form a Solution

Focused Logistics Wargame (FLOW)

HQ USAF/IL

The Joint Staff J-4 will oversee this biennial single-sided seminar-style wargame that will assess each Service's ability to support *Joint Vision 2010* (JV 2010) levels in a 2004-2010 environment. The Navy has lead Service responsibility for the first game which will take place 19-22 October 1999 at the Naval War College. The Air Force will host the second game (FLOW 02) in 2001 at the Air Force Wargaming Institute.

The overall goal of FLOW is to investigate, in a 21st century environment, the desired operational capabilities required to satisfy the Focused Logistics challenges of information fusion, joint deployment and rapid distribution, force protection, medical support, multinational logistics, joint theater logistics management and agile infrastructure.

Air Force objectives for FLOW are:

- Demonstrate the effectiveness and efficiency of Agile Combat Support (ACS) to deploy and sustain Aerospace Expeditionary Forces (AEFs) as the basic aerospace component of joint operations.
- Evaluate the concept of operations (CONOPS) for Agile Logistics by evaluating how it supports the AEF through application of two-level maintenance, time-definite delivery and total asset visibility/intransit visibility.
- Evaluate the ability of ACS to provide comprehensive, end-to-end force support planning, deployment, bed-down, employment, sustainment and reconstitution in support of joint operations.
- Assess the impact of weapons of mass destruction (nuclear, biological and chemical) on sustainment (for example, distribution, maintenance and operations tempo).
- Evaluate the effectiveness of ACS models and decision support tools to accurately and realistically depict combat support functions and provide credible analysis and courses of action.
- Evaluate Total Force (including Air National Guard and Air Force Reserve Command) and DoD civilian contributions to ACS—commitments, readiness and responsiveness.

The Joint Staff J-4 is authoring wargame scenarios that span the target timeframe (2004 through 2009) and the full spectrum of conflict from small humanitarian operations to major theater warfare. Seven distinct areas will be involved in the scenarios. These areas, termed pillars, are listed in Table 1. Seven pillars will be led by Navy general officers and supported by Air Force general officers and Senior Executive Service members as subpillar chairs. Working groups in each area will examine Service issues in the scenarios and evaluate how the Services are structured to support JV 2010. They will also examine the proposed scenarios and recommend changes that will allow FLOW to effectively meet the J-4 and Service-specific objectives.

HQ USAF/ILXX is the coordinator for FLOW and heads the Air Force FLOW Interim Project Team. The Air Force Logistics Management Agency is the executive agent for Air Force logistics play development in FLOW. *(Ms. Felicia Johnson, USAF/ILXX, DSN 223-7168)*

Expeditionary Aerospace Force Implementation

The Expeditionary Aerospace Force (EAF) Implementation Program Action Directive (HQ USAF PAD 99-01) is under development and projected for publication in May 1999. A program action directive is designed to describe an Air Force initiative to accomplish a major action. It is purposely broad in scope and leads to the major command (MAJCOM) development of the program plans that are more detailed and focus on the tasks and milestones. The EAF PAD includes the CONOPS in Annex A and functionally aligned annexes providing guidelines to MAJCOMs, direct reporting units and field operating agencies

Concurrently with the EAF PAD, AF/XOP is developing an Air Force Instruction (10-series) that is also scheduled to be published in May 1999. Additional information and copies of briefings and articles can be found on the EAF Worldwide Web page (http://*eaf.dtic.mil*, no www). *(Lt Col Chuck Cotterell, USAF/ILXS, DSN: 225-6812, cotterellc@pentagon.af.mil)*

Name	Office	Pillar
Ms. Leclaire (SES-1)	AF/ILX	Logistics Management and Information Systems
Mr. Dunn (SES-4)	AF/ILM	Ordnance
Brigadier General Stewart	AF/ILS	Readiness/Sustainability
Major General Ferraro	AFC/LG-MA	Strategic Mobility/JRSO&I
Mr. Ainmore (SES-2)	AF/ILE	Engineering & Construction
Brigadier General Stierle	AF/SG	Health Services
Mr. Batterman (SES-3)	AFMC/LG	Wholesale Logistics

Table 1. Focused Logistics Air Force Subpillar Chairs

(*Aircraft Airworthiness Symbols and Mission Capable Codes* continued from page 12)

serious symbol is the Red Diagonal, which essentially means an unsatisfactory but airworthy condition exists. Red Diagonal conditions, such as the malfunction of a non-safety-of-flight equipment item, are not sufficiently urgent or dangerous to warrant grounding the aircraft.

The overall airworthiness of the aircraft is identified by use of one of the status symbols marked in the STATUS TODAY block of the Air Force Technical Order (AFTO) Form 781H, Aerospace Vehicle Flight Status and Maintenance Document. This form is generally the first in the 781 series that personnel will see when reviewing an aircraft forms binder. The status block of the 781H should always reflect the most severe symbol used in any of the subsequent 781 forms, such as the 781A, Maintenance Discrepancy and Work Document.

It is the responsibility of the individual discovering a discrepancy to document it in the 781s. Once an individual has documented a discrepancy, no one may order or direct that person to change the symbol. However, if a more qualified individual believes the condition to be more serious, he/she may upgrade it. There are a wide variety of circumstances where a discrepancy might be discovered and documented. If an aircrew discovers a discrepancy during a mission, it is their responsibility to document it on the appropriate 781 form and/or report it during the debriefing after flight, at which point debriefing personnel will document it. Likewise, it is the mechanic's responsibility to properly document all discrepancies and maintenance. All maintenance, whether or not it corrects the discrepancy, must be documented. To ensure potential discrepancies are not forgotten, documentation must be completed before the mechanic leaves the job site. Maintenance documentation instructions concerning airworthiness symbols and discrepancies are provided in TO 00-20-5, *Aerospace Vehicle Inspection and Documentation*.

Mission Capability Codes

While airworthiness symbols indicate if an aircraft is fit for flight, mission capable status codes reflect the capability of the aircraft to accomplish its mission, sometimes called aircraft status. The basic status codes are not mission capable (NMC), partially mission capable (PMC) and fully mission capable (FMC). A key tool used to help assign mission capable status is the Minimum Essential Subsystems List (MESL). The MESL identifies the aircraft systems or subsystems that must be working for mission accomplishment. It contains two separate lists: the Basic System List (BSL) and the Full System List (FSL). The BSL identifies a unit's specifically assigned wartime, training and test missions and the systems and subsystems that must be working to accomplish those missions. The FSL shows all systems and subsystems needed to complete the BSL missions and other unit sorties; for example, program depot maintenance delivery flights.

In most MAJCOMs, the flight-line expediter determines aircraft status and coordinates it with the production superintendent and the maintenance operations center. For an aircraft to be coded as FMC, all systems, subsystems and components identified as needed in the FSL must be working. PMC means the aircraft is capable of doing at least one, but not all, of its missions. This code is assigned if one or more systems, subsystems or components needed for safe aircraft operation during peacetime or identified as needed in the FSL are not working. An NMC code is assigned when the aircraft cannot perform any of its assigned missions. While airworthiness symbols are documented in the maintenance AFTO 781 forms binder, aircraft mission capable status codes are recorded in the Core Automated Maintenance System (CAMS) or CAMS for Airlift (G081) in the case of Air Mobility Command. Reporting instructions are provided in Air Force Instruction 21-103, *Equipment Inventory, Status, and Utilization Reporting*.

It is important to note that airworthiness symbols and mission capable codes are related but not interchangeable. For example, a Red X symbol necessitates assignment of an NMC code since accomplishment of a BSL mission requires flying the aircraft and the aircraft is considered unfit for flight. However, an NMC does not necessarily result in a Red X. An aircraft may be flyable but not capable of accomplishing the mission.

This brief overview makes a distinction between airworthiness symbols and mission capable status codes. It provides general information concerning assignment of codes and documentation. Guidance on the use of airworthiness symbols is provided in TO 00-20-1. Likewise, specifics on the use of mission capable status codes can be found in Air Force Instruction 21-103.

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Have You Thought About—

I don't ever, ever, ever want to hear the term logistics tail again. If our aircraft, missiles, and weapons are the teeth of our military might, then logistics is the muscle, tendons, and sinew that make the teeth bite down hard and hold on—logistics is the jawbone! Hear that? The JAWBONE!

—Lieutenant General Leo Marquez

You will not find it difficult to prove that battles, campaigns, and even wars have been won and lost primarily because of logistics.

—Dwight D. Eisenhower

(*Transforming Enabling Processes: The Next Step in Logistics Reform* continued from page 3)

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(*Providing Responsive Logistics Support: Applying LEAN Thinking to Logistics* continued from page 38)

An important piece of the lean solution is to squeeze the queue time out of the process. Doing so reduces the average pipeline length and thus the amount of stuff needed to fill (the average portion of) the pipeline. Generally reducing the queue time also reduces the variability in the process. If the variability is reduced, then we do not need as much stuff in our protection buffers—another savings. As you can see, reducing queue time is very important.

Use Fast Transportation Everywhere

First, let's define what is meant by fast. When an asset is moved fast, it experiences little or no queue time. It does not wait for a cart, pallet, truck or whatever to fill up before it is moved to the next step in the process. As the engineers say, stuff is moved in *transfer batch* sizes of one. This is the most important piece of fast transportation. However, fast also means moving the asset in the quickest way practical. For most items, this means next-day air or dedicated truck.

Now that we have an understanding of each piece of the lean logistics solution, let's take a look at Figure 6, which ties them all together.

Each of these bold square boxes contains a piece of the lean logistics solution. To understand how these pieces fit together to support the objective at the top, read each of the arrows in Figure 6 from tail to tip as *If . . . Then* statements, where the ellipses serve to indicate logical *ands*.

As Figure 6 highlights, in order to achieve the potential benefits of leaning our logistics processes, it is necessary to implement all the pieces. Recognizing and understanding the interrelationships between these pieces is key to successfully eliminating the age-old problem of logistics. It is much like baking a cake—none of the steps is overly difficult. However, if we skip a step or leave something out, the result usually falls far short of our expectations.

Norman Patnode is a first time contributor to the Air Force Journal of Logistics.

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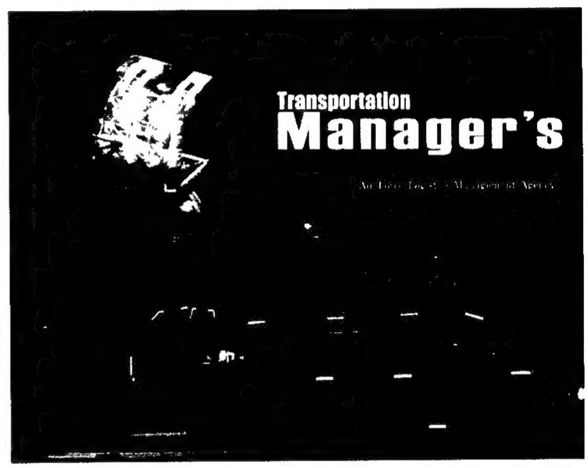

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